LumaSense™ TECHNOLOGIES

Instruction Manual

1314i Photoacoustic Gas Monitor

BE6030-11

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1314i Photoacoustic Gas Monitor

October 2012

Safety Considerations.

Throughout this manual Monitor is used for:
Photoacoustic Gas Monitor – INNOVA 1314i

The Monitor complies with:

- EN/IEC 61010-1, 2nd Edition: Safety requirements for electrical equipment for measurement, control and laboratory use.

- Can/CSA-C22.2 No. 61010-1-04 - Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use.

- UL Std. No. 61010A-1 (2nd Edition) - Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use.

To ensure safe operation and retain the Monitor in safe condition, note the following:

EXPLOSION HAZARD!

TO AVOID THE POSSIBILITY OF AN EXPLOSION; MONITORING OF FLAMMABLE GASES IN EXPLOSIVE CONCENTRATIONS MUST NEVER BE ATTEMPTED.

Never operate the 1314i Photoacoustic Gas Monitor in potentially explosive environments.

When monitoring potentially flammable or toxic gases it is essential that:

- The instrument itself is placed in a well-ventilated area outside the potentially hazardous zone.

- A sufficiently long tube is connected to the air-outlet on the back panel so that the sampled gas is carried away to the open air or to an extraction and/or filtration unit.

Environmental Condition for transport and storage:

Temperature:	-25 to +55ºC
Relative Humidity:	0 to 80% RH
Atmospheric Pressure:	800 to 1060 hPa

Warnings!

- Avoid water condensation in the instrument.
- Switch off all equipment before connecting or disconnecting their digital interface. Failure to do so could damage the equipment.
- Whenever it is likely that correct function or operating safety of the apparatus has been impaired, the apparatus must be made inoperative and secured against unintended operation.
- Any adjustment, maintenance and repair of the open apparatus under voltage must be avoided as far as possible and, if unavoidable, must be carried out only by trained personnel.
- If a fault is reported by the monitor that indicates correct function of the instrument may be impaired, consult your local LumaSense Technologies representative. Under no circumstances should repair be attempted by persons not qualified in service of electronic instrumentation.

Applying Power

Before using the 1314i check that the available mains voltage match the specified voltage and frequency for the instrument.

SAFETY SYMBOLS

⚠

The apparatus will be marked with this symbol when it is important that the user refers to the associated warning statement given in the User Guide.

Frame or Chassis Dangerous voltage Protective earth

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Chapter 1

Using this Manual

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1.1 Introduction

This manual can be used in several ways. The first time users can work their way through the examples in order to get to know this monitoring system. The more experienced users can jump directly to the relevant chapters in order to gain assistance, and experts can use this manual as a reference book by using the index.

The monitor can be operated in three ways; Online Monitoring using LumaSoft Gas Single point 7810, Calibration , back-up and Offline using the Gas Monitoring Software 7304, and as a Stand-alone instrument. Therefore, the instructions in this manual are divided in to the following sections; PC use with Gas Monitoring Software 7304 and Stand-alone Use.

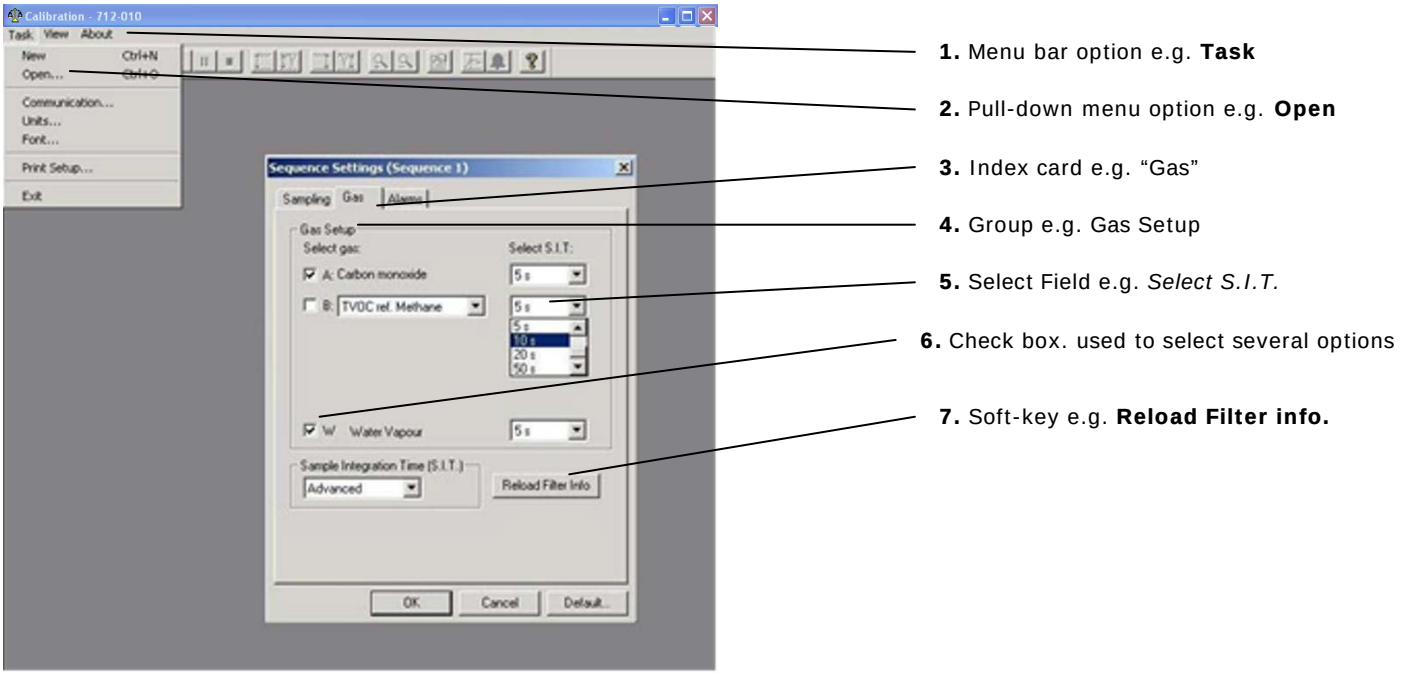
1.2 Online Monitoring

LumaSoft Gas Single Point 7810 is supplied with the instrument. This is to be used for Online monitoring (PC use) please follow the instructions in the BE6027 user manual for online monitoring and set-up.

1.3 PC Use 7304

The instruction under this heading should be followed whenever the monitor is used together with the Gas Monitoring Software 7304. Both Online (Calibration and Back-up) and Offline instructions are covered here.

The information displayed on screen is presented in this manual as shown below:



Radio push-buttons: these are not illustrated above, but are commonly used in the software. They act as a toggle function when several options are available, but only one can be selected at a time.

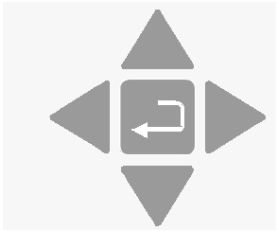
1.4 Stand-alone Use

In some situations, it may be necessary to set up without connecting it to a PC. The procedure to do this are covered in this manual under the Stand-alone use headings. The way these instructions are presented is shown below:

The display above is used continuously through-out this manual. It assists you displaying the text on screen and by indicating which of the push-buttons can and should be pressed.

In general, the push-buttons shown above are used to navigate through the various modes possible within the 1314i but are described in more detail below:

These push-buttons are illustrated as S1, S2 and S3. On the 1314i they correspond to the key and their position on the instrument.
These select push-buttons enable you to select one of the options displayed.



This group of 5 push-buttons are referred to in this manual collectively as the direction keys. The symbols below are used to simplify the instruction in this manual.

▲ & ▼ enable you to increase & decrease numbers, respectively, or to go to the Previous & Next Displays, respectively.

◄ & ► enable you to move across number fields or go to the Previous & Next gases, respectively.

↵, depending on the situations, acts as an “Enter” or “Go To Head” key.

Memory Function push-buttons are always represented with the name of the push-button enclosed in a box which is shaded-in.

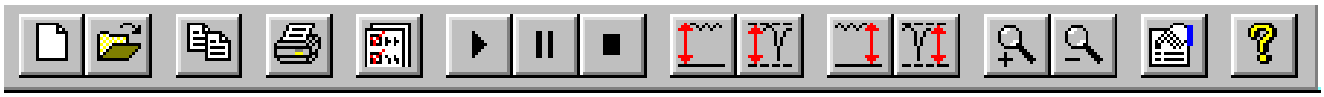
SYSTEM Text that appears on the display screen is shown in an open shaded box, using UPPER case letters.

FORMAT **System** ***General*** ***Clock***

When referring to any part of the Set-up “tree”, the text is shown in open shaded boxes with the same typeface as that used in the “tree”.

1.5 Tool-bar Icons in Gas Monitoring Software 7304

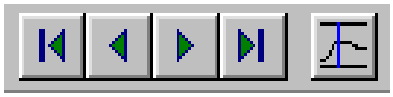
The instructions in this manual use the pull-down menu paths to describe how operations are possible. However, in many cases, the icons in the tool-bar can be used to speed things up.



1 2 3 4 5 6 7 8 9 10 11 12 13

The text below provides the key to the icons.

1. Create a new measurement task.
2. Open an existing measurement task.
3. Copy active window to clipboard.
4. Print active screen.
5. Change sequence settings.
6. *Calibration only*- Start a measurement sequence.
7. *Calibration only*- Pause a measurement sequence.
8. *Calibration only*- Stop a measurement sequence.
9. Auto-scale axis from 0 to maximum value (only available when the Auto-scale OFF is selected in the windows properties dialogue).
10. Auto-scale axis from minimum to maximum values (only available when the Auto-scale OFF is selected in the windows properties dialogue).
11. Zoom in (only available when two cursors are selected).
12. Zoom out (only available when zoom is enabled).
13. Display the active window properties.



14

14. Open the cursor values dialogue.

Chapter 2

Preliminary Tasks

October 2012

When taking delivery of the 1314i Photoacoustic Gas Monitor, five very important and preliminary tasks must be completed before starting to operate it:

Install the Gas Monitoring Software 7304 (to enable operation (Back-up, Calibration and upload of data from the Monitor's internal Memories) from via a PC) (see section 2.1).
Connect the Monitor to a PC (see section 2.2).
Check/Change the fuses in the monitor (see section 2.3).
Set the Communication parameters. USB (see section 2.4), RS232 (see section 2.5), TCP/IP (see section 2.6).
Set-up the password protected user levels (see section 2.7).

2.1 Installing the Gas Monitoring Software 7304.

Before installing the software, the PC must meet the following requirements:

Hardware:	A personal Computer, Pentium 166 MHz or better Min. 64 Mbytes of RAM Min. 40 Mbytes of space available on the hard disc VGA monitor or better One RS-232 port Mouse
Software:	Windows NT, Windows 2000, Windows XP

It is recommended to install the latest version of the Windows Service Pack.

The software comes complete with an installation program. Insert the disc and use the standard Windows procedure to install the software. When installing the software you must be logged in as an Administrator that means that you must have "administrator" rights.
The users, who are going to use the software, must have "Standard User" rights, in order to be able to use the software. "Restricted User" rights will not be sufficient to operate the program. It is recommended that your system administrator performs the task of installing the program and creates the user logins with the proper user rights to operate the software.
If you are unsure how to install programs, refer to the Windows Help.

After the installation is successfully completed, five icons appear in the Gas Monitoring Software 7304 program menu. These are labelled:

ONLINE

PRESENTATION

CALIBRATION

OFFLINE

DATABASE ADMINISTRATION

These icons can be placed on your desktop for easy access to the programs.

Please Notice:
We recommend using the 7810 user SW for online monitoring.

2.2 Connecting the Monitor to the PC

The monitor comes complete with a USB interface cable. The maximum length of an USB cable is 5 meters. USB extension kits can be used to extend the USB connection to 30 meters.

The gas monitor can also be connected to a PC using a 9-pin to 9-pin null modem RS-232 interface cable (optional accessory WL950-003).

Finally the monitor can be connected to a PC using the Ethernet (TCP/IP) network connection.

2.2.1 Fitting the RS-232 Cable.

Ensure that both the monitor and the PC are switched off at the mains. Failure to do so may result in your equipment being damaged.
Locate the serial port at the back of the PC; refer to your PC manual if in doubt.
Push the connector on the RS-232 cable on to the serial port socket, and secure it firmly using the securing screws.
Locate the output labelled “RS-232” at the back of the Monitor.
Push the connector at the other end of the RS-232 cable on to this socket, and secure it firmly using the securing screws.
Turn on the PC. Wait for Windows to start up.

The instruments can be turned on at the mains now.

2.2.2 Fitting the USB Cable.

The gas monitor can be connected to an USB port on the PC in order to make measurements using the LumaSoft Gas Single Point 7810 PC application, which communicates using the USB interface communication protocol.

The USB interface cable can be connected while the gas monitor is switched on.

2.2.3 Fitting the Ethernet (TCP/IP) Cable.

The gas monitor can be connected to a local Ethernet network in order to make measurements using the LumaSoft Gas Single Point 7810 PC application, which communicates using the TCP/IP network interface protocol or to view the homepage of the gas monitor in a standard PC internet browser.

The Ethernet network cable can be connected while the gas monitor is switched on.

Connect a standard Ethernet network cable to the Ethernet socket connector on the back of the gas monitor. Connect the other end of the Ethernet network cable to your local network. The yellow LED on the Ethernet socket connector will lit, if a local network connection is detected.

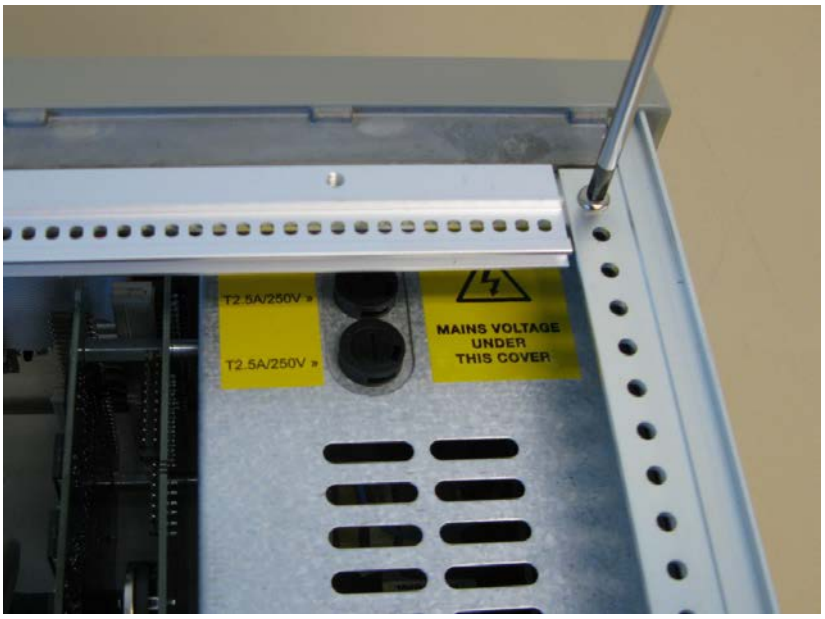
2.3 Checking /changing the Fuses in the Monitor.

Unplug the Monitor from the mains power supply and pull out the plug in the AC Mains socket of the Monitor
If the fuses in the Monitor are blown it can indicate a serious fault in the instrument, therefore it is advisable to contact your LumaSense service representative before changing the fuse!

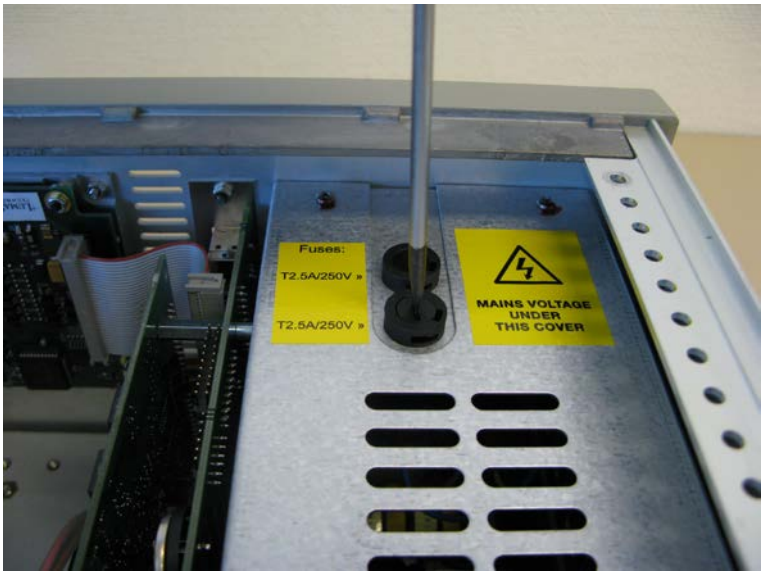
2.3.1 Checking / changing the Fuses in the 1314i

1. Remove the top lid.

2. Remove the rear cross rail:



3. Use a screwdriver to remove the fuse-holder:

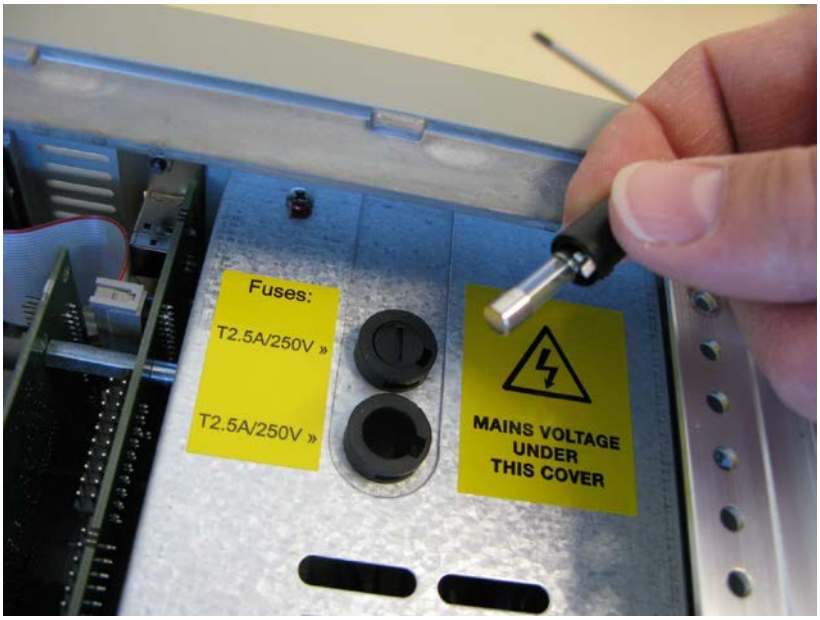


4. Remove the old fuse from the holder and replace it with a new. Check that the fuse have the correct rating.

The fuse must be:

Slow-blow (T) fuse with a rating of 2.5 A, 250 VAC, 5x20 mm, UL approved.

LumaSense order number: VF0102A



5. Install the fuse-holder and re-assemble the 1314i again.

2.4 Installing the 1314i in a 19” rack

When installing the 1314i in a 19” system rack.
Place the Gas Monitor on a Shelve or support it by using Slide Rails.
Secure the Front frame to the 19” section with appropriate screws.

2.5 Setting the USB Communication Parameters

The LumaSoft Gas 7810 application with USB communication is able to communicate with the 1314i gas monitor through a USB cable.

No setup on the 1314i gas monitor is necessary in order to be able to communicate with the 1314i gas monitor through an USB connection.

2.6 Setting the RS-232 Communication Parameters

The Gas Monitoring Software 7304 and the monitor communicate using the RS-232 interface. In order for the communication to be successful, it is essential that the communication parameters in the two instruments are set correctly. This is a two stage process: the PC communication port is selected via the Gas Monitoring Software 7304 while the baud rate, parity, data bits and stop bits are defined via the monitor.

The communication parameters necessary for the monitor to communicate with the Gas Monitoring Software 7304 are shown below:

Baud rate	9600
Stop bits	1
Data bits	7
Parity	Even
Hardwire mode	Leased line
Handshake type	Hardwire

These are set as the default values in the monitor.

To prevent communication errors, the text line terminator, print data log and print error log must be set as shown below.

Text line Terminator	CR-LF
Print Data Log	NO
Print Error Log	NO

2.6.1 Selecting the PC (RS-232) communication Port

It is just a simple case of selecting the correct port on the PC. The software offers four to choose from: COM1, COM2, COM3 and COM4. If you are not sure which port the cable is connected on your computer refer to your PC manual.

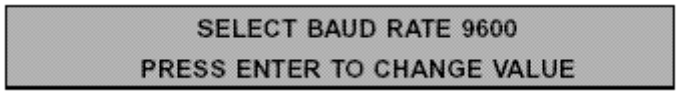
Start any one of the Gas Monitoring Software 7304 options: Online, Offline or Calibration.

Pull down the **Task** menu. Click on **Communication**. The communication dialogue is displayed.
Click on the radio push-button next to the correct port name.
Click on **OK** to store the selection and exit this dialogue.

2.6.2 Checking/Changing the RS-232 Communication Parameters

The communication parameters for the serial interface must be set using the push-buttons on the front of the monitor.

1. Press **SET-UP** **S3** **S1** **S3** **S1** .The screen display now shows the following text.



If the baud rate displayed is incorrect press ↵ and use ▲ and ▼ to display the correct value. Press ↵ again to store the selection.
If the baud rate displayed is correct, then press ▼ to continue to the next parameter.
Press **S1** to select 1 STOP BIT.
Press **S1** to select 7 DATA BITS
Press **S2** to select EVEN PARITY
Press **S3** to select LEASED-LINE
Press **S3** to select HARD-WIRED HANDSHAKE.
Press **SET-UP** to exit the set-up mode
Press **RESET** and **S1** in order that the new settings are enabled.

The monitor and the Gas Monitoring Software 7304 are now able to communicate together.

2.6.3 Checking/Changing the Text line Terminator.

The Text line Terminator must be set using the push-buttons on the front of the monitor.

Press **SET-UP** **S2** ▼**S3**

Press **SET-UP** to exit the set-up mode

2.6.4 Checking/Changing the Data Log and Error Log Options.

The Data Log and Error Log must be set using the push-buttons on the front of the monitor.

Press **SET-UP** **S3** **S1** **S1** **S3** ▼**S1** **S1**

Press **SET-UP** to exit the set-up mode

2.7 Setting the Ethernet (TCP/IP) Communication Parameters

The LumaSoft Gas 7810 application with TCP/IP communication is able to communicate with the 1314i gas monitor through a local Ethernet (TCP/IP) network.

The homepage of the 1314i gas monitor can also be displayed in a web browser, when the 1314i gas monitor is connected to a local Ethernet (TCP/IP) network.

2.7.1 Checking/Changing the TCP/IP Communication Parameters

The communication parameters for the TCP/IP interface can be set by using the push-buttons on the front of the monitor.

1. Press **SET-UP** **S3** **S1** **S3** **S2**. The screen display now shows the following text.

SELECT ADDRESSABLE SET-UP BRANCH	
TCP/IP	**IEEE 488**

2. Press **S1** to enter the TCP/IP setup. During this setup you can also use the ▲ and ▼ keys to go back and forth between the available TCP/IP settings. The screen display now shows the following text.

IS 1314i'S IP ADDRESS SET BY DHCP ?	
NO	YES

3. Here you can select whether the IP address of the 1314i gas monitor is to be assigned by a DHCP server in the local network. If you want the 1314i's IP address to be assigned by the DHCP server press the **S3** (Yes) key, where after you will proceed to the below step 6 as the IP address by the DHCP server. If you want yourself to set the IP address of the 1314i press the **S1** (No) key. The screen display now shows the following text.

1314i'S IP ADDRESS 192.168.000.200
PRESS ENTER TO CHANGE VALUE

4. Here you can change the IP address of the 1314i gas monitor in case the IP address is not set by a DHCP server in the local network. If you want to change the IP address, press the ↵ key. If the IP address does not need to be changed, press the ▼ key and you will proceed to the below step 6.
   If you selected to change the IP address, the screen display now shows the following text.

1314i'S IP ADDRESS 192.168.000.200	
CANCEL	DEFAULT

5. Here you can change the 4 individual numbers in the IP address by using the ▲ and ▼ keys. Each of the 4 individual numbers can be set in the range from 000 to 255.
   You can step between the 4 individual numbers in the IP address by using the ◄ and ► keys.
   In case you want to return to the start value of the IP address press the **S1** (CANCEL) key. In case you want to return to the default stored value of the IP address press the **S3** (DEFAULT) key.
   When you have set the IP address, press the ↵ key. The screen display now shows the following text.

1314i'S IP PORT NUMBER: 23
PRESS ENTER TO CHANGE VALUE

6. Here you can set the IP port number for the TCP/IP communication. This normally does not need to be changed. If you want to change the IP port number press the ↵ key. If the IP port numbers does not need to be changed, press the ▼ key and

you will proceed to the below step 8. If you selected to change the IP port number the screen display now shows the following text.

```
1314i'S IP PORT NUMBER:     23
  CANCEL                DEFAULT
```

7. Here you can change the IP port number by using the ▲ and ▼ keys. The port number can be set in the range from 0 to 32767.
   In case you want to return to the start value of the IP port number press the **S1** (CANCEL) key. In case you want to return to the default stored value of the IP port number press the **S3** (DEFAULT) key.
   When you have set the IP port number, press the ↵ key. The screen display now shows the following text.

```
PROTECTED IP ADDRESS 000.000.000.000
PRESS ENTER TO CHANGE VALUE
```

8. In case you want the 1314i gas monitor to be able to communicate only with a certain PC on the local network, you can set the IP address of this PC as the protected IP address. This can be desired due to security reasons so no other PC is able to communicate with the 1314i gas monitor.
   If no protection is desired the protected IP address should be set to a value of 000.000.000.000.
   If you want to change the protected IP address, press the ↵ key.
   If the protected IP address does not need to be changed, press the ▼ key and you will proceed to the below step 10.
   If you selected to change the protected IP address the screen display now shows the following text.

```
PROTECTED IP ADDRESS 000.000.000.000
  CANCEL                DEFAULT
```

9. Here you can change the 4 individual numbers in the protected IP address by using the ▲ and ▼ keys. Each of the 4 individual numbers can be set in the range from 000 to 255.
   You can step between the 4 individual numbers in the protected IP address by using the ◄ and ► keys.
   In case you want to return to the start values of the protected IP address press the **S1** (CANCEL) key. In case you want to return to the default stored value of the protected IP address press the **S3** (DEFAULT) key.
   When you have set the protected IP address, press the ↵ key.

If you previously selected that the IP address NOT to be set by the DHCP server you will proceed to the below step 11.
If you instead selected that the IP address to be set by the DHCP server, the screen display now shows the following text.

CURRENT DHCP ADDRESS 192.168.000.062 **ACCEPT**

10. Here the IP address of the 1314i, which has been assigned by the DHCP server, is displayed. This IP address can be used to manually set TCP/IP communication in a PC application, which accesses the 1314i gas monitor.

Press the **S2** (ACCEPT) key to accept.

11. This concludes the setup of the TCP/IP parameters of the 1314i gas monitor.
Press the **SET-UP** key to leave the setup.

2.8 Setting-up user Levels

Press the **Lock** function push button on the front of the Monitor.
This enables setting up 3 different user levels, Level 1, Level 2 and Level 3.
These user levels are password protected.

Level 1 is the *Operator* level, which enables start/stop and reading of measurement results. Partial Reset is possible.
Level 2 is the *Expert* level, which in addition to Level 1 access enables set up of parameters. Full Reset is possible.
Level 3 is the *Super-User* level, which allows all possible operations including calibration.

2.8.1 Default settings for User Level and Password.

Before dispatch from the factory the User Level and the Password are set to the following default setting.

User Level 3

And the default setting for the Password is:

Password: ***** (5 times *)

These settings are to be used to change user level or password the first time.

2.8.2 Changing the Password

In order to change the Password Press the **Lock** function push button on the front of the Monitor.

The following text is displayed.

CURRENT USER LEVEL IS X	
CHANGE USER LEVEL	CHANGE PASSWORD

Press **S3** "CHANGE PASSWORD"

The following text appears.

ENTER PASSWORD "******"
PRESS ENTER TO CHANGE VALUE

1. Press ↵ to change value.

The following text appears.

ENTER PASSWORD "******"	
CANCEL	DEFAULT

2. Enter the old Password using the ▲ and ▼ keys.

3. Press ↵.

The following text appears.

PASSWORD IS "******"
PRESS ENTER TO CHANGE VALUE

4. Type in the new Password using the ▲ and ▼ keys.

5. Press ↵.

2.8.3 Changing the User Level

In order to change the User Level Press the **Lock** function push button on the front of the Monitor

The following text is displayed.

CURRENT USER LEVEL IS X
CHANGE USER LEVEL CHANGE PASSWORD

1. Press S1 "CHANGE USER LEVEL"

The following text appears.

ENTER PASSWORD "******"
PRESS ENTER TO CHANGE VALUE

2. Press ↵.
3. Enter the current Password using the ▲ and ▼ keys.
4. Press ↵.

The following text appears.

CURRENT USER LEVEL IS X
PRESS ENTER TO CHANGE VALUE

5. Press ↵.
6. Use the ▲ and ▼ **keys** to change the User level.
7. Press ↵.
8. Press the **Lock** function push button to exit.

2.8.4 User Levels in the Gas Monitoring Software 7304.

When using the Gas Monitoring Software 7304 the software checks the user level setting of the monitor.

Calibration can only be activated when user Level 3 is selected on the monitor.
If user Level 2 or 1 is defined the following error is displayed on screen.

Calibration
Warning: Not allowed to make Calibration
User level 3 must be selected on instrument to make Calibration
(Use the LOCK button)
OK

2.9 Download of the latest 7304 version

You will find the latest version of the 7304 software on
http://innova.lumasenseinc.com/downloads/innova73040/
Please obtain a login/password from LumaSense Technologies representative in order to enter the download section.

2.10 Restoring of calibration data

If you have ordered a calibration from our calibration laboratory, you will receive a diskette with a backup of the calibration data. It is very important that you store these data in your Gas Monitoring Software 7304, which you just have installed. Please store the data before using the Gas Monitoring Software 7304; **otherwise the storing procedure will cause overwriting of existing calibration data**.

Example 1

Storing of calibration data

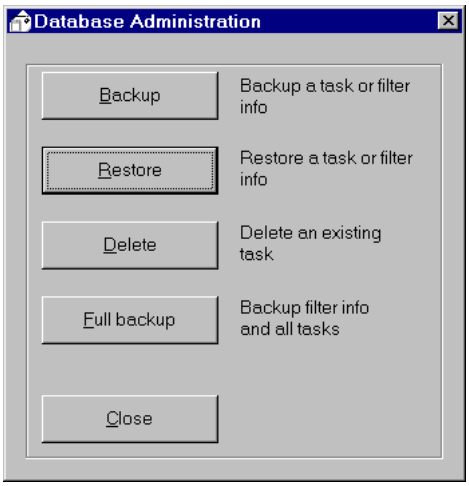
Assume that you have ordered a calibration of your monitor, which have 2 optical filters installed: UA0986 and UA0973. For these two filters you have ordered calibration with Acetaldehyde and Ammonia.

Filter A	UA0986	Acetaldehyde
Filter B	UA0973	Ammonia

After calibration, the calibration data is stored in a calibration task with the Gas Monitoring Software 7304, and the data is copied to a CD. This calibration task is named as:

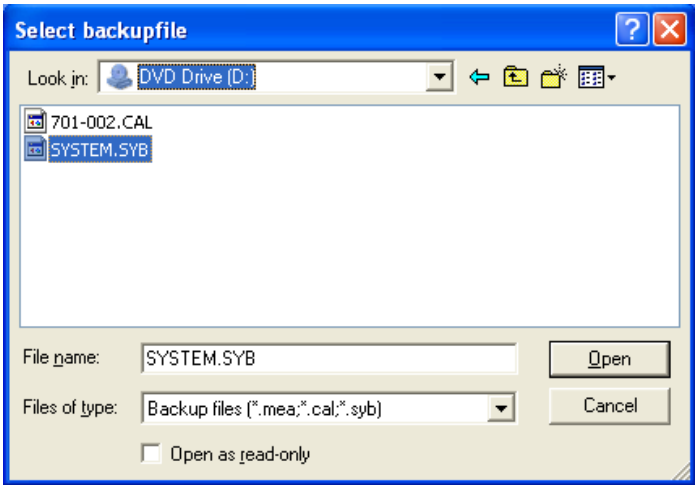
***Serial No*.CAL** ex. **701-002.CAL**
(Single calibration task have been ordered.)

Please insert your backup CD in the CD-ROM drive.
Start the Database Administration program:



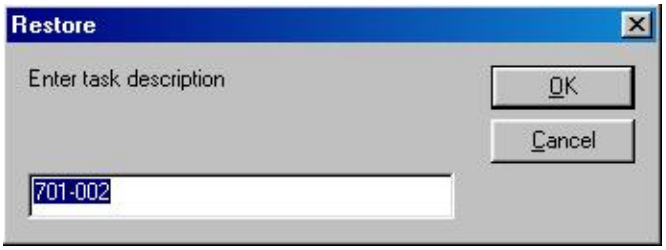
Select "**Restore**", and select the respective CD-ROM or DVD drive:

Following window appears.



Please store all files from the CD.

The **System.syb** contains the calibration task data, and the ***x*.CAL** file contains the filter calibration data.

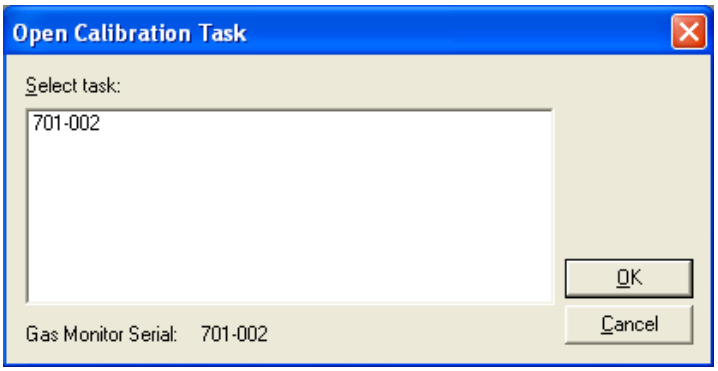


Please store the **System.syb** file first and thereafter the ***x*.CAL** file.

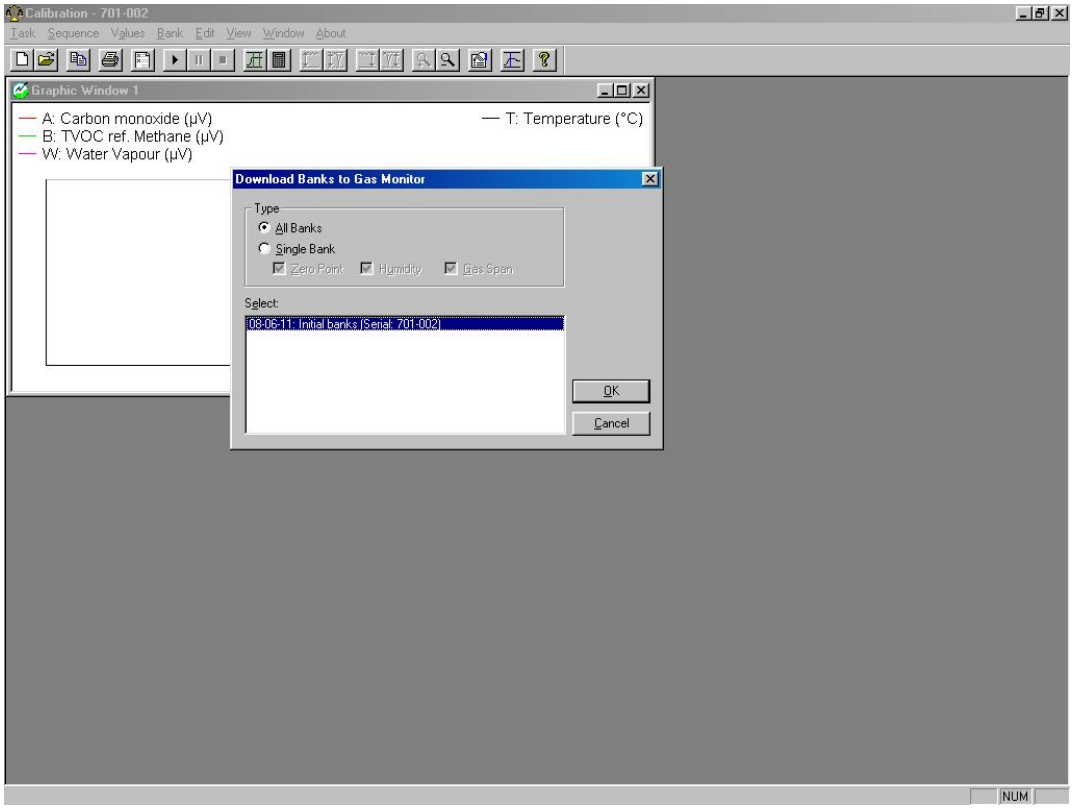
Enter a task description.

And select back-up file.

After storing the calibration data, you will find the calibration task in the **Calibration** program:



Under the **"Bank"** and **"Download Banks to the Gas Monitor"** menu bottoms you will find the calibration data:



Your **Gas Monitoring Software 7304** is now 'loaded' with the calibration data, and is now ready for use.

Example 2

Storing of calibration data from a multi calibration task including different filters.

In this example, we assume that you have ordered two different calibrations of your Dual-gas Monitor:

Calibration task no. 1:

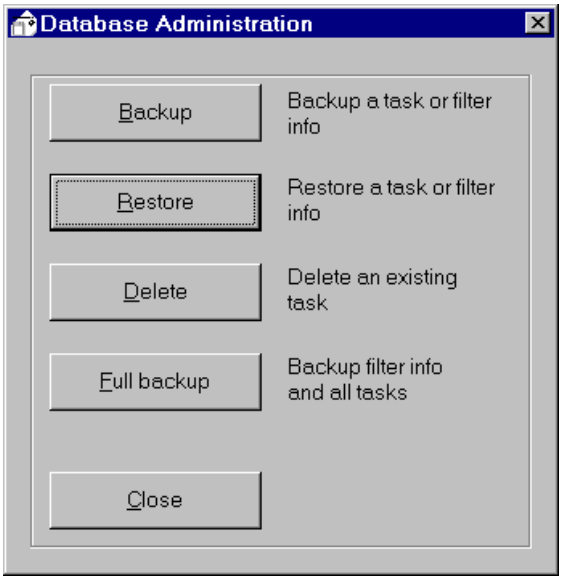
Filter A	UA0984	Carbon monoxide
Filter B	UA0987	TVOC ref. methane

Calibration task no. 2:

Filter A	UA0983	Carbon dioxide
Filter B	UA0988	Sulphur hexafluoride

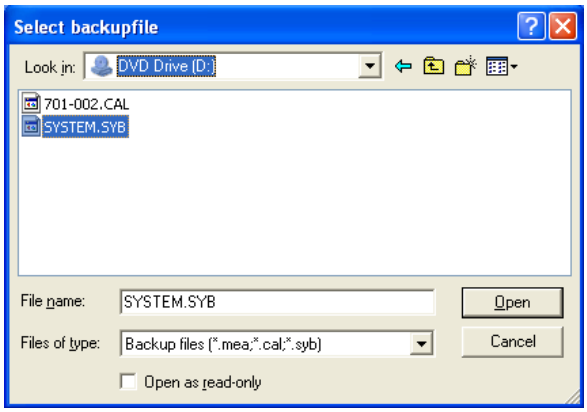
After calibration, the calibration data is stored in a calibration task, and the data is copied to a CD. The calibration task is named as:

Serial No.CAL ex. 701-002.CAL
Please insert your backup CD in the CD-ROM drive.
Start the Database Administration program:

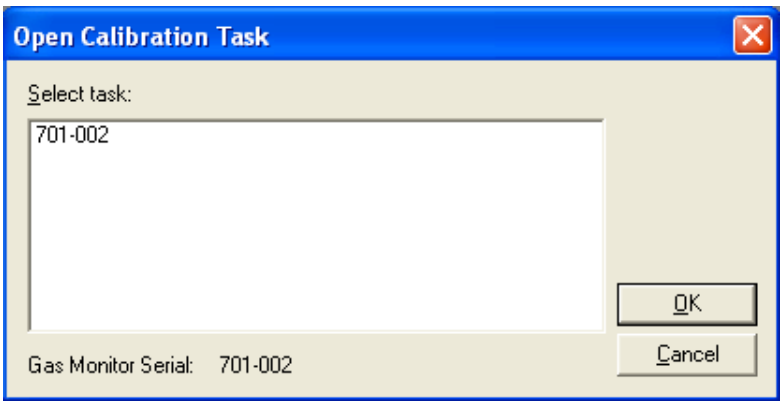


Select **"Restore"**, and select the respective CD-ROM or DVD drive:

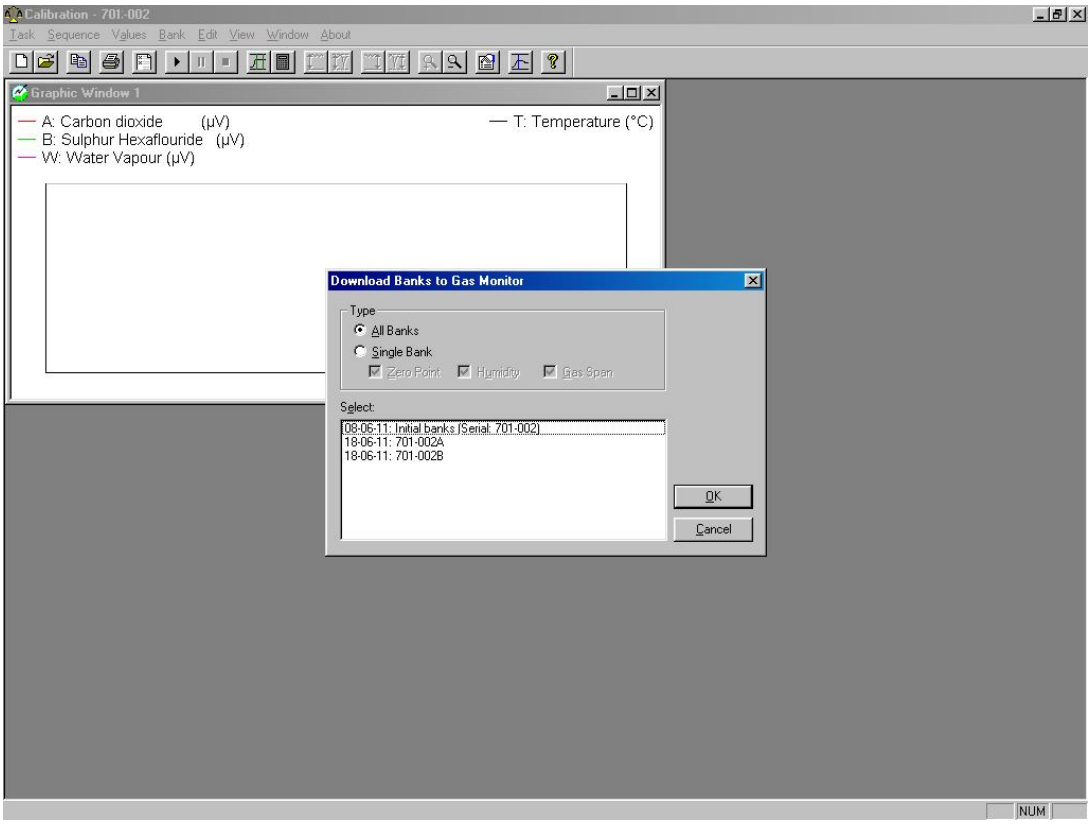
Please store all files from the CD.
The **System.syb** contains the calibration task data, and the ***x*.CAL** file contains the filter calibration data. Please store the **System.syb** file first and thereafter the ***x*.CAL** file.



After storing the calibration data, you will find the calibration task in the **Calibration** program:



Under the **"Bank"** and **"Download Banks to the Gas Monitor"** menu bottoms you will find the calibration data, for the different set-ups (filter configurations):



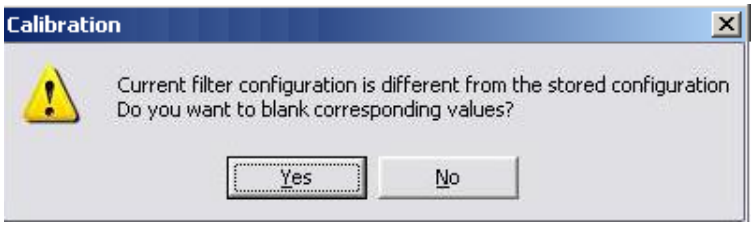
Your **Gas Monitoring software 7304** is now 'loaded' with the calibration data, and is now ready for use.

Change of the configuration (set-up) of optical filters can only be performed from the front-panel of the instrument.

If the filter configuration has been changed after the back-up was performed the following message will appear on the screen:

Select OK.
Filter info is retrieved from the instrument.

Before using **"Download Banks to the Gas Monitor"**, it is necessary to set-up the right configuration in the Gas Monitor from the front panel see section 14.3.3.
If there is a conflict between the set-up of optical filters in the monitor and the calibration data in the Back-up file the following warning appears.



When a new set-up is stored in the monitor following message appears the first time the monitor is connected to the software.

Select OK.

The new optical filter data from the monitor is then transferred to the Gas Monitoring Software 7304.

Chapter 3

Philosophy of Operation

October 2012

The monitor has several essential operational features, which enable you to operate it without undue reference to this Instruction Manual. The main features of the monitor which ensure its simple and easy operation, are listed below:

- The fully, comprehensive Gas Monitoring Software 7304.
- The LumaSoft Gas Single Point 7810 application software.
- The short, self-explanatory texts, which appear in the monitor display when the monitor is being used, give operational guidance to the user.
- The small light-emitting diodes at some of the push-buttons allow the user to identify how the monitor is operating at any particular time.
- Audible warning “beep” if any push-buttons are used in the wrong way.

3.1 PC Use – Online

A monitoring system, where you use the PC environment to set-up the monitor prior to measuring, display measurement data on the PC screen while monitoring and store the measurement results directly on the PC’s hard disc. The LumaSoft Gas Single Point 7810 application software is used for making online measurements. The measurement results can be used by other programs that fetch data from the SQL Server Express database server featured by the 7810 application. A manual BE6027 for the 7810 application is available for reference.

Using the online mode (7810 Application Software) provides you with a variety of Software Alarm options. Not only are the alarm trigger levels definable, but the action resulting from an alarm being triggered can also be defined here. This enables you to connect external warning systems to the monitoring system.

The philosophy behind the 7810 Application Software is common to almost all Windows programs. Access to the various levels of the program is gained by use of the MENU BAR, PULL-DOWN MENUS, NEW WINDOW options and INDEX-CARD separators. These familiar procedures, together with the simple software structure, make the instructions in the On-line sections of this manual understandable and easy to implement.

If you are unsure of any of the commands used in the On-line instructions, please refer to section 1.2 of this manual or your Windows manual.

3.2 PC Use – Offline 7304

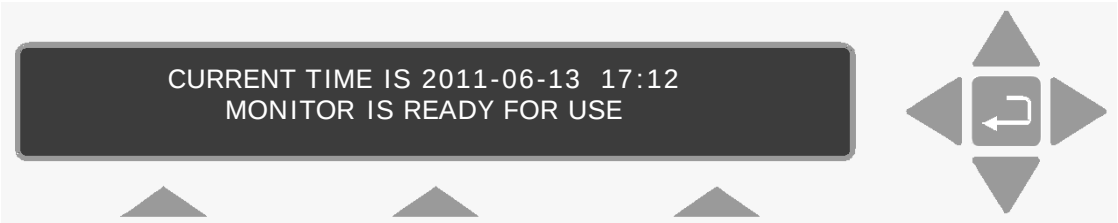
This method of operation enables you to set-up the monitor using the PC, download the set-up to the monitor, and then disconnect the PC. The monitor is ready for use as a stand-alone instrument. While monitoring, the monitor stores all the measurement results in its internal memory. On completion of the monitoring task, the PC and the monitor can then be connected again and the results uploaded to the PC. These results can then be displayed on the PC screen analysed and, if necessary, are available to other software programs.

3.3 Stand-alone Use

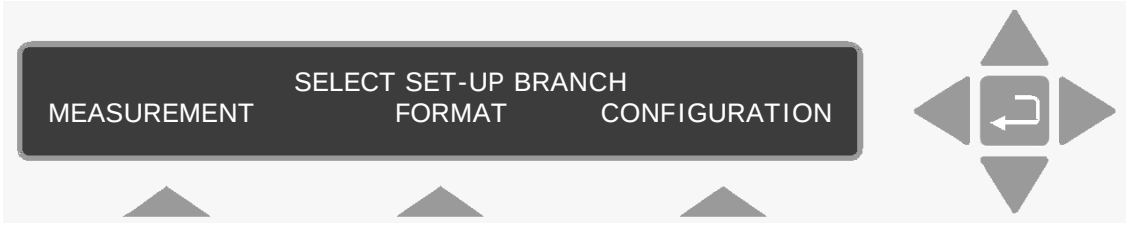
This method of operation is available to those of you who wish to use the monitor without connection it to a PC. The monitor is set-up and the results are displayed via the monitor's front panel.

The structure of the monitor set-up can be viewed like an inverted tree. The main branches divide and separate into minor branches. These in turn divide again and again.

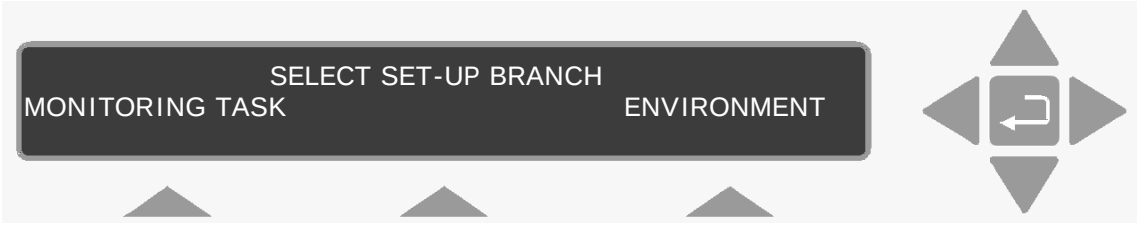
To move through the tree, the branches are selected using the "select" push-buttons (see section 1.4). Use the Set-up Tree, supplied with the monitor and the example steps below to see how the instructions progress. Starting from the initial screen display.



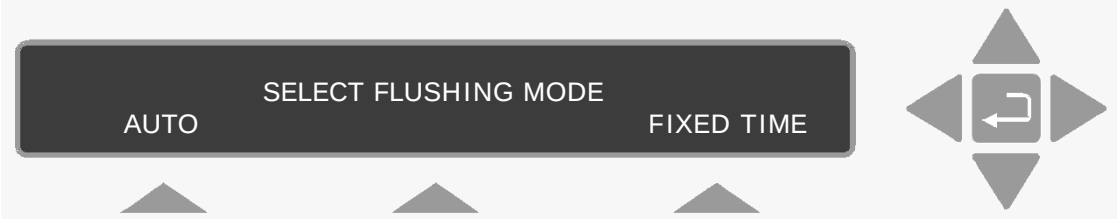
1. Press **SET-UP**, and the text changes to that displayed below.



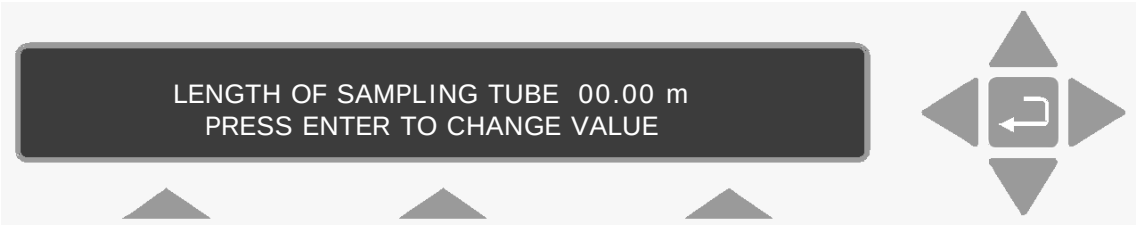
2. To select the **MEASUREMENT** branch, press **S1**. (Pressing either of the other "select" push-buttons will take you along another branch of the set-up tree. The following text is displayed.



To select the **ENVIRONMENT** branch, press **S3**. The text is displayed.



3. To select the **AUTO** flushing mode, press **S1**. The following text is displayed.



This branch does not divide again. At this stage you are able to define the parameters in this branch of the tree using the direction push-buttons.

If the branch had divided again, it is a simply process of using the correct "select" push-button to continue down the desired branch.

Parameters that are already selected are displayed either with a cursor under the current selection or the value is displayed on the top line.

When the correct value or parameter is already selected, you can continue on through the tree using the ▼direction push-button.

To exit SET-UP mode press **SET-UP**

Defining parameters is covered in section 6.1.

The procedures in the example above are common to all the situations where the “select” push-buttons can be used to access the different levels in the monitor.

Chapter 4

Introduction to and Familiarization with the Monitor

October 2012

The Monitor is an extremely versatile measuring instrument, which can be used to perform almost any kind of monitoring task. Its versatility may appear overwhelming at first, but to avoid such a reaction, we suggest that you read this chapter thoroughly, and follow the practical exercises, which are included. These exercises give you a “guided tour” through a number of different practical procedures – monitoring task; performance of a monitoring task; scrolling through data after completion of a monitoring task. By following these different procedures the Monitor operating philosophy will become apparent and you will be able to quickly familiarise yourself with its operation and control.

4.1 Special Terminology

Certain terms are used to describe the operation of the Monitor and it is necessary to fully understand what these terms mean before you start any practical exercise with the Monitor.

4.1.1 Measurement Cycle

A description of a measurement cycle is given on page 2 of the Product Data Sheet (see boxed-in text and schematic diagram of the measurement system of the Monitor). “Measurement Cycle” is the term used to describe everything that takes place in the Monitor from the time the pump starts to flush out the “old” gas sample in its analysis cell, until the signal in the measurement chamber has been measured using the last relevant optical filter.

The time taken to complete a measurement cycle is dependent upon the following factors:

How many gases/vapours are being measured – this affects the number of optical filters which need to be used.
The sample integration time selected – longer measurement times provide greater accuracy.
The flushing times selected for the measurement chamber and the tube as well as the length of the sampling tube attached to the Monitor’s air-inlet – the longer the tube, the more time is needed to flush it out between measurement cycles.
The cleanliness of air-filters which filter the air drawn into the cell (this affects the pumping time required to draw a fresh air sample into the analysis cell).
The degree of fluctuation in the concentration of the various gases measured in consecutive measurement cycles (this affects the time required to adjust the gain of the amplifier attached to the microphones).

Table 4.1 gives some indication to the measurement times depending on the number of gases measured and the measurement times selected. However, these times may vary from one measurement cycle to another due to the cleanliness of the filters and the degree of fluctuation in the concentration of the various gases.

Table 4.1 Approximate measurement times

Monitor Setup	Volume of Air	Response Times
S.I.T.: “Normal” (5s) SIT : “Low Noise” (20s) Flushing: Auto, (tube 1m)	140 cm^3/sample	One gas: ~27s 5 gases + water: ~60 s 5 gases + water: ~150 s
S.I.T.: “Fast” (1s) Flushing: Chamber 4s, Tube “OFF”	20cm^3/sample	One gas: ~13s 5 gases + water: ~26s

4.1.2 Monitoring Task

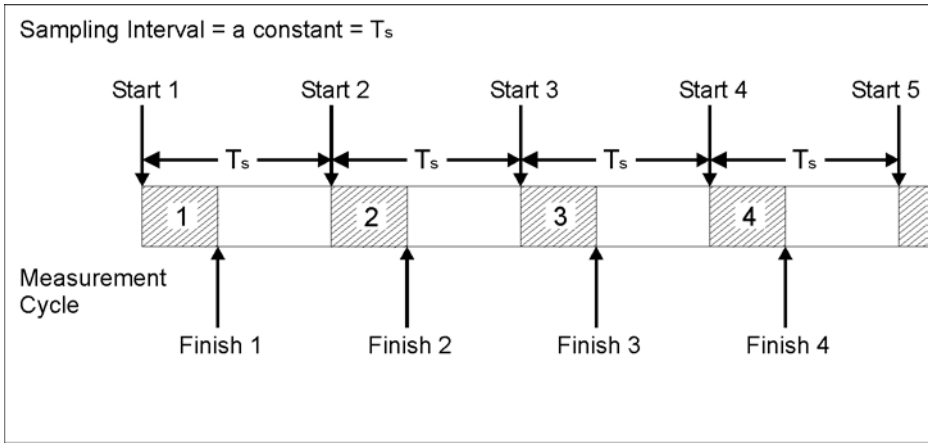
A monitoring task consists of a series of similar measurement cycles. These cycles can either be repeated at regular intervals or be continuous:

4.1.3 Sampling Interval

The sampling interval is a measure of the time between the start of one measurement cycle and the start of the following measurement cycle.

When the Monitor is **not** sampling continuously the sampling interval has to be defined by the user and is a fixed period of time (see Fig.4.1).

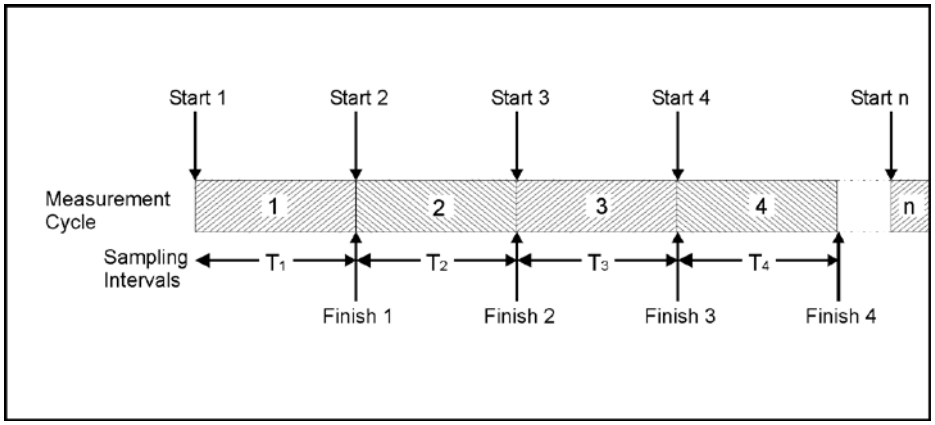
Fig.4.1 An illustration of the fixed sampling intervals of the monitor when it is not sampling continuously.



4.1.4 Continuous Sampling

The Monitor is said to be sampling continuously when each measurement cycle is followed immediately by another similar measurement cycle (see Fig.4.2).

Fig.4.2 An illustration of continuous sampling



4.1.5 Monitoring Period

The monitoring period is the time between the **start** of the first measurement cycle in a monitoring task and the **finish** of the final measurement cycle in a monitoring task.

The monitoring period can either be pre-set by the user – in which case the Monitor automatically stops monitoring after the monitoring period is over – or, **not** pre-set – in which case the Monitor will continue to monitor until the user stops the monitoring task manually (see section 4.3.8).

4.2 Attaching the Sampling Tube and External Filter

1 Cut a short section of sampling tube of Poly-Tetra-Fluoro-Ethylene (Teflon) tubing, (optional accessory).

2 Using Fig.4.3 and the instructions below, attach one end of this tube to the air-inlet stub on the back-panel of the Monitor.
Push one end of the Teflon tubing through the non-threaded end of the nut.
Hold the end of the tubing between the fingers and gently push the tubing over the end of the Monitor's air-inlet stub as far as it will go.
Note: if the tubing is bent/broken during this procedure, remove the tubing from the stub and repeat this step using an undamaged length of tubing.
Screw the threaded-nut firmly onto the end of the air-inlet stub.

Purge
Outlet
Change filter paper regularly
Inlet Air Filter
Do not touch inside of air-filtration unit
Use tweezers and gloves when changing filter paper

Fig.4.3 Attaching tubing to the air-inlet stub and the external filter

3. Attach the other end of the sampling tube to the external air-filter which is provided as an optional accessory.

4.3 Familiarization with the Monitor using Front Panel

4.3.1 Setting the Internal Clock

Before dispatch from the factory, the internal clock of the Monitor is set to the correct local (Danish) time. If the monitor is to be used as a stand-alone instrument, then the clock can be adjusted to your local time using the following instructions.

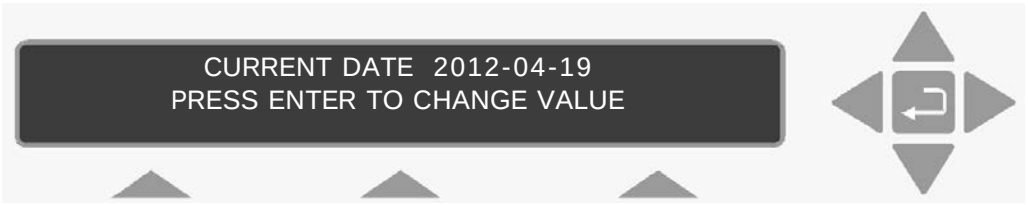
1. Switch on the AC Mains power switch on the back-panel of the Monitor.

2. Press **SET-UP**.

Refer to the Set-Up Tree, supplied with the Monitor, so that you can follow your movement through the various branches of this “tree” in the following sequence of button presses.

3. Press **S3** **S1** **S1**.

The following screen picture appears:



Dates are entered as the Year-Month-Day, for example the 19th April, 2012 has to be entered as 2012-04-19.

4. To change the date, press ↵.

5. Use the direction keys to enter the correct date.
   Note: press **S1** to revert back to the original date.

6. Press ↵ to accept date.

   This causes the text on the display screen to change to the following:

7. To change the time, press ↵.

8. Use the direction keys to enter the correct time. If you make a mistake in entering the correct date just press **S1** and start again.

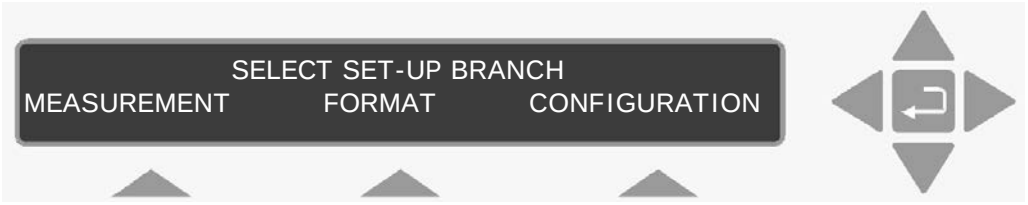
The current time is entered as the time read on a 24-hour digital clock. For example, 13:45 is 15 minutes to 2 o'clock in the afternoon.

9. Press ↵ to accept time.

When this step is completed, the display then moves to the **previous** head of the Set-Up Tree.

10. Press ▲ three times and follow the path you take *en route* through the Set-Up Tree.

The screen display shows the following text:



11. Press **SET-UP** to exit.

4.3.2 Setting Units

All data in the Monitor is stored as raw data. The different units, which you can select here, enable you to enter gas concentrations and to display temperatures, lengths and pressures in units, which you are comfortable with. These units are also used to present measurement data in a form that is most convenient for you.

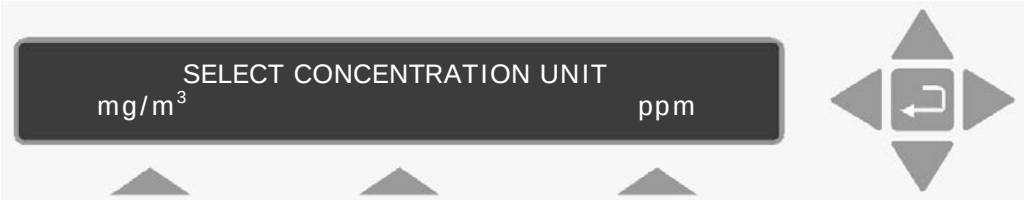
The Monitor can display gas concentrations either in absolute units of mg/m3 unit that is dependent on a particular temperature, termed the **normalization** temperature, or in units of parts per million (by volume) – which is independent of the temperature of the gas. You can inform the monitor about the units you intend to use – for example: the length of the sampling tube attached to the Monitor's inlet (in meters or feet) atmospheric pressure (kPa or mBar or mmHg) and unit for humidity (ppm or Tdew or kPa or mg/m^3).

The measurement units can be changed using the push-buttons on the front of the monitor:

1. Press **SET-UP**.

2. Press **S3** and then **S2**.

The following text appears on the screen display:

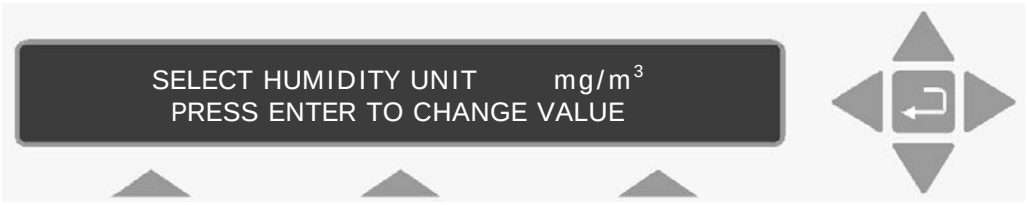


The cursor appears under the unit which is presently in the **active** set-up.

3. Press **S1** to select mg/m^3.

4. Select metres as the unit of length, °C as the temperature unit, and kPa as the pressure unit by using a procedure similar to that described in the previous steps.

After the pressure unit has been selected the following text appears on the display:



There are more than three humidity units to choose from therefore the means by which a unit is selected differs:

5. Press ↵.

6. Use ▲ & ▼ to scroll through the options.

7. When Tdew is displayed, press ↵.

The display automatically returns to the head of the **CONFIGURATION** setup branch.

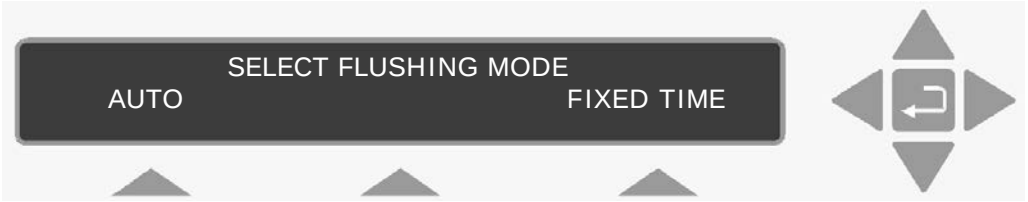
8. Press **SET-UP** to exit.

4.3.3 Setting the Environment Parameters

Environmental parameters describe the factors which influence the measurement situation – the length of the sampling tube attached to the Monitor and the normalization temperature. These parameters are discussed more fully later on in this section.

1. Press **SET-UP**, **S1** and then **S3**.

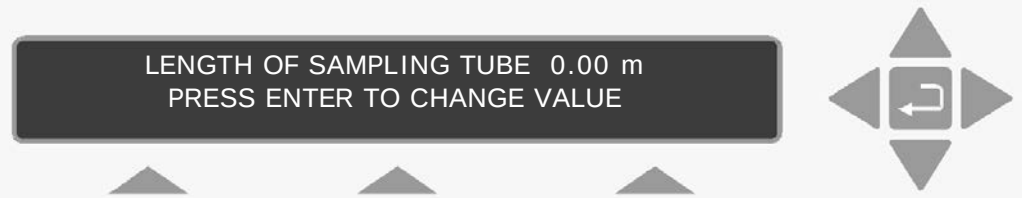
This brings you into the **Environment** branch of the Set-Up Tree where the following text is displayed:



The Auto option regulates the flushing time depending on the sampling tube length and the cleanliness of the air-filter (as the filter become dirtier, the flushing time will increase). The Fixed Time option is divided in to two parts; chamber flushing time and sample tube flushing time. Once defined, these times are constant regardless of the sampling tube length and cleanliness of the filters.

Auto Option

a. Press **S1**, and the following display appears.

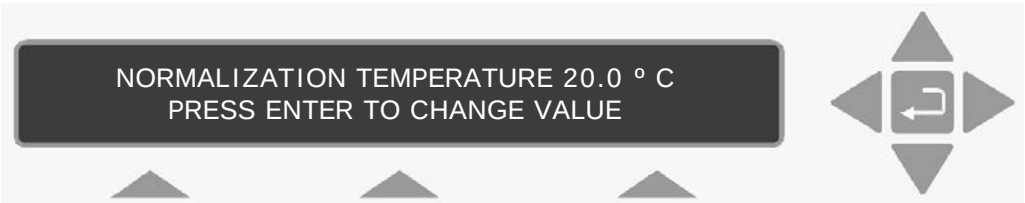


b. Press ↵.

c. Use the direction keys to define the tube length: ▲ and ▼ to increase and decrease.
The numbers, respectively; ◄ and ► to move the cursor across the fields.
Change the length of the sampling tube shown on the screen to the length of the tube you attached to the Monitor in section 4.2.
Note: the range of acceptable values for the sampling tube ranges from 00.00m to 99.00m.

d. Press ↵ to select displayed length.

The following display appears:



The Monitor measures gas concentrations in the absolute unit of mg/m^3 – a unit which is **dependent** on temperature. Alternatively, the Monitor can calculate gas concentrations in parts per million (ppm) by volume – this unit is **independent** of the temperature of the gas. If mg/m^3 is chosen as the gas concentration unit it is therefore necessary to define the temperature at which you wish the Monitor to calculate gas concentrations. This pre-defined temperature is termed the **NORMALIZATION TEMPERATURE**.

e. Press ↵ to change value.

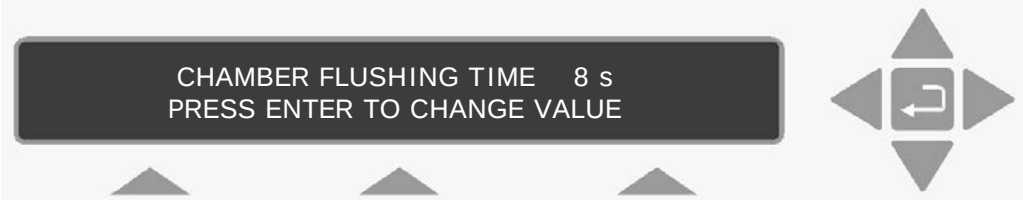
f. Use the direction keys to define the normalization temperature: ▲ and ▼ to increase and decrease the numbers, respectively; ◀ and ▶ to move the cursor across the fields.

g. Press ↵ to select displayed temperature.

The display screen then jumps to the "head" of the **MEASUREMENT** branch of the Set-Up Tree and the following text is shown:

Fixed Time Option

a. Press **S3**, and the screen displays the following text.

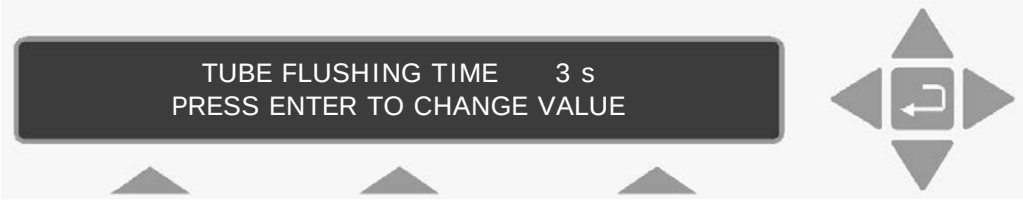


b. Press ↵.

c. Use the direction keys to define the chamber flushing time.
Note: the range of acceptable values for chamber flushing ranges from 2s to 60s, increasing in 1s intervals.

d. Press ↵ to select displayed flushing time, and the following text is displayed.

e. Press **S3** to enable sample tube flushing. The screen displays the following text.

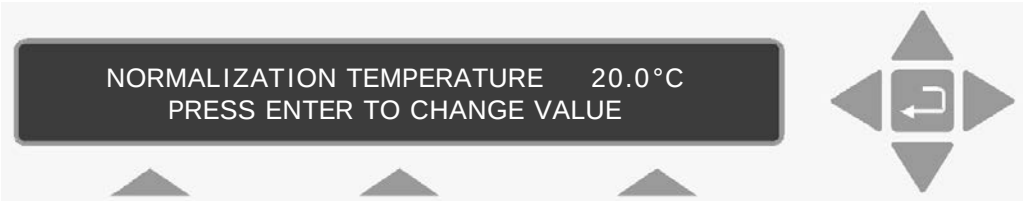


f. Press ↵.

g. Use the direction keys to define the tube flushing time.
Note: the range of acceptable values for tube flushing ranges from 3s to 120s, increasing in 1s steps.

h. Press ↵ to select displayed flushing time.

The following text is displayed.



i. Press **SET-UP**

4.3.4 Setting up a Monitoring Task

The optical filters in the monitor have to be calibrated before they can be used to measure gas concentrations. The user can only set-up a monitoring task using those optical filters which have been installed. In this example we have chosen to measure gas A (that is, to measure gas A's concentration using the optical filter installed in position "A" of the filter carousel) and water vapour.
If your Monitor has only been calibrated to measure with another filter (for example, the filter in position "B") then choose gas B to replace gas A in the following instructions. The parameters which describe the monitoring task we shall set-up, are listed below:

Stand-alone Settings

Monitoring Task Set-up Number = **1**

Sampling = **Continuous**

Monitor for preset period = **No**

Compensate for Water Vapour Interference = **Yes**

Compensate for cross-interference = **No**

Measure Gas A: XXXXXX = **Yes**

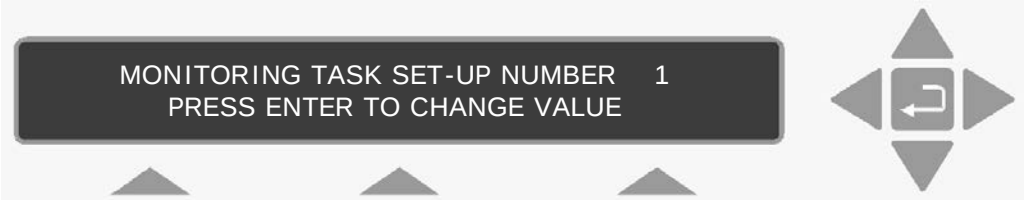
Measure Gas B: XXXXXX = **No**

Measure Water Vapour = **Yes**

***Note**: flushing is set in Environmental Parameters, section 4.3.3, and the S.I.T's are set up in the Filters setup, section 14.3.3*

1. Press **SET-UP**, **S1** and then **S1**.

This brings you into the **Monitoring Task** branch of the Set-Up Tree where the following text is displayed:



Up to 10 different monitoring tasks can be set-up while operating the Monitor in **Set-up** mode. The parameters describing these tasks are automatically stored in the memory of the Monitor.

2. If the number on the display is already "1" then press ▼ to "accept" the value.

If the number is not "1":

a. Press ↵ and use the direction keys to change its value to "1".

b. Press ↵ to accept the value.

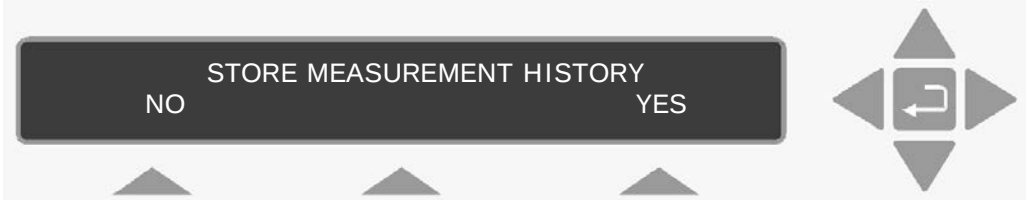
The text which appears on the display during the next step is really self-explanatory and it is therefore possible for you to follow why the button-pushes listed in the next step will set-up the monitoring task which is described at the beginning of section 4.3.4.

3. Press **S3** **S1** **S3** **S1** **S3**, then press **S1** until the text **MEASURE WATER** **VAPOUR** appears on the display.

4. Press the **S3** button to answer "YES" to measure water vapour.

4.3.5 Store Measurement History.

The following screen is displayed.



a. If you select to answer No, then only the last measured values are stored in the display memory.

b. If you select to answer Yes all measured values are stored in display memory.

5. Press the **S3** button to answer "YES" to store the measurement history.

Once this step is complete, monitoring task number 1 has been set-up and the display moves to the previous head of the Set-Up Tree.

6. Press **SET-UP** to exit the **Set-Up** mode.

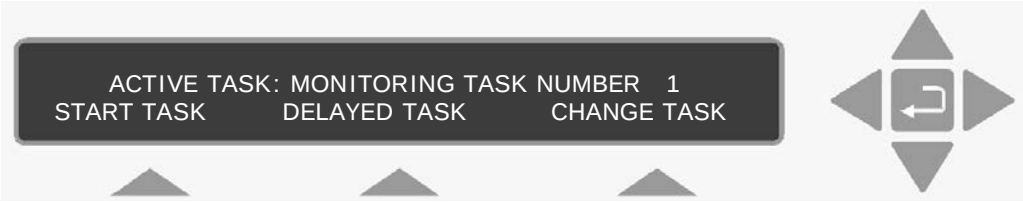
4.3.6 Starting a Monitoring Task

Note: before a monitoring task can be started, the Measurement Units, Environment Parameters and Monitoring Task Settings must be defined, see sections 4.3.2, 4.3.3 and 4.3.4.

This section will explain how to perform a monitoring task – for example, monitoring task number 1 which was set-up in section 4.3.4.

1. Press **MEASURE**.

The following text appears on the screen:

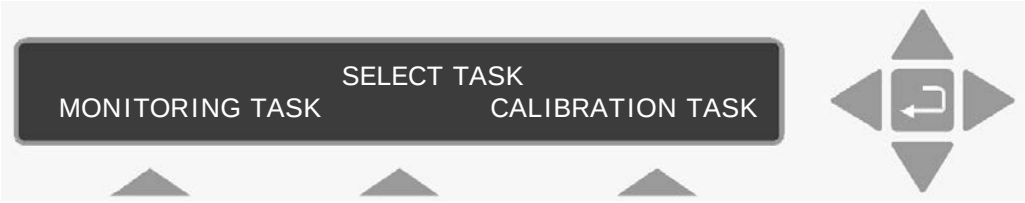


Please note: if you do not use one of the "select" keys within a short time after the above text appears, the Monitor will automatically stop operating in **Measure** mode (the light-emitting diode in the **MEASURE** key switches off).
If this happens just press **MEASURE** again.

The active monitoring task number is the number of the monitoring task you wish the Monitor to perform.

2. If the number on the display **is** number 1 then go to step 5.
   If the number on the display is **not** number 1 then press **S2** to change the task number to number 1.

This changes the display text to the following:



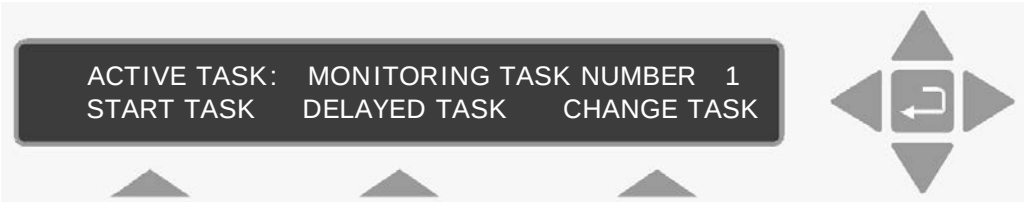
3. Press **S1**.

This causes the following text to appear on the display:

The number appearing on the screen will be a number from 1 to 10.

4. Press ↵ and use the direction keys to change the monitoring task number to 1.
   Then press ↵ again to accept the task number.

The following text appears on the display screen:



5. Press **S1** to start the monitoring task.

The following warning then appears on the display:

Display Memory is where the Monitor stores the results of all measurements while it is performing a monitoring task. If the monitoring task is stopped and then started again all the data already collected will be deleted from Display Memory. However, the data in *Display Memory* can be copied into and stored in the Monitor's *Background Memory*. This operation is described in section 11.2.

6. Press **S1**.

The following text then appears on the screen:

MEASUREMENT IN PROGRESS
RESULTS NOT YET AVAILABLE

7. When the first measurement cycle is complete the Monitor will automatically display the results and update them every time a new measurement cycle is completed. An example is shown below:

This display gives the overview of the gas/vapour concentrations last measured – in this case the concentration of gas A and humidity of the water vapour are in the units that were selected – that is mg/m^3 for gas A and Tdew for water vapour (see section 4.3.2).

4.3.7 Displaying Measurement Results while a Monitoring Task is in Progress

If STORE MEASUREMENT HISTORY is selected in the MEASUREMENT set-up branch (see section 4.3.5) all measurement data collected during a monitoring task is stored in Display Memory together with the parameters which describe the task (see section 4.3.4).

Using the direction keys, you can scroll through this data.

1. After the monitoring task has been running for 10-15 minutes, press ▼.

An example of the text which appears on the screen is shown below:

DATA IN DISPLAY MEMORY RECORDED FROM
2011-01-16 09:50 TO 2011-01-16 10:04

This screen text allows you to find out how long the monitoring task has been running here from 9:50 to 10:04 on the same day. The date on the right-hand side of the display indicates the time at which the last measurement cycle was completed while a monitoring task is in progress this date is, of course, constantly updated.

2. Press ▼ and then use ◀ & ▶ until the following text appears on the display:

FILTER A USED TO MEASURE
(the name of the gas will appear here)

The displays which follow indicate the type of text which appears each time ▼ is pressed:

GAS A:	MAX 84.5E+00	μ 8.03+00
ALARM 1_____	MIN 7.42E+00	σ 2.36E+00

While a monitoring task is being performed a running statistical analysis of the monitored gases/vapours is made and the results are displayed as shown above, where:

MAX = maximum concentration of gas A measured during the period of time the monitoring task has been performed.

MIN = minimum concentration of gas A measured during the period of time the monitoring task has been performed.

ALARM 1 = the user-defined concentration of gas A which, if measured by the Monitor, will trigger a switch in the Monitor and activate an external alarm relay connected to it.

μ = linear average, or mean value, of all the gas A concentrations measured during the period of time the monitoring task has been performed

σ = standard deviation of gas A's concentrations from the mean value (μ) described above (see section 9.1 for further details).

All numbers are written in the exponential form, for example:

$$84.5E+00 = 84.5 \times 10^{+0} = 84.5$$

The concentration unit in this case is mg/m3 as this was chosen in the **active** set-up (see section 4.3.2).

3. Press ▼.

A: (the name of the gas being measure by Filter A will appear here)	**972.06 mBar**
2011-01-16 09:50:32 _____	**7.42 mg/m3**

A: (the name of the gas being measure by Filter A will appear here)	**972.06 mBar**
2011-01-16 09:51:33 _____	**7.42 mg/m3**

As you can see, the display provides the date and time at which the measurement was made, and the concentration of gas A is given in the units mg/m^3 because this was the unit chosen for gas concentration in the **active** set-up. The dashed lines, which appear

after the time will be replaced by a number as soon as the monitoring task has been stopped (see section 4.3.8).

After scrolling through the list of individual measurement results for gas A, the following text is displayed:

SAMPLING IS CONTINUOUS

MONITORING PERIOD IS NOT PRE-SET

COMPENSATION FOR WATER VAP. INTERFERENCE

MONITORING TASK STARTED 2011-01-16 09:50

MEASUREMENT CHAMBER TEMPERATURE 29.6°C

SAMPLE INTEGRATION TIME				**W: 5s**
A: 5s	**B:___s**	**C:___s**	**D:___s**	**E:___s**

A:Carbon monoxide	**B:_____**	**C:_____**
D: _____	**E:_____**	**W: WATER VAP**

A: 7.42E+00	**B: _____**	**C:_____**
D: _____	**E: _____**	**W: 8.13+00**

The last display above shows the up-dated overview of the gas concentrations measured during the most recent measurement cycle. This display does not appear, after the monitoring task has been stopped.

Data collected during a monitoring task i stored in the *Display Memory* of the Monitor and therefore, before a new monitoring task is started, all data stored in this memory is deleted. *Display Memory* has finite size, and therefore there is a limit to how much data can be stored in it. Once this memory has been filled-up all subsequent data collected during the task will start to overwrite the data already collected during the start of the monitoring task. **Only** in this event will the date displayed after the text **MONITORING TASK STARTED** on the above screen be different from the **earliest** date on the display (shown below) which give the most up-to-date overview of the monitoring task:

DATA IN DISPLAY MEMORY RECORDED FROM 2011-01-16 09:50 TO 2011-01-16 10:04

4. Press ▶.
This causes the following text to appear on the screen:

WATER VAPOUR MEASURED

Use ▼ to scroll through the following screen displays:

MONITORING PERIOD IS NOT PRE-SET

WATER:	MAX 8.55E+00	μ 8.15+00
	MIN 7.01E+00	σ 816E-03

W: WATER VAPOUR:	971.88mBar
2011-01-16 09:50:32 _____	7.39Tdew

W: WATER VAPOUR:	971.88mBar
2011-01-16 09:51:33 _____	7.49Tdew

5. Press ▶.
This causes the display to jump over to the list of measurement results for gas A. The following text appears:

A: (the name of the gas being measure by Filter A will appear here)	972.06 mBar
2011-01-16 09:51:33 _____	7.43 mg/m3

By using ▲ and ▼ you can now scroll through the list of measurement results for gas A.

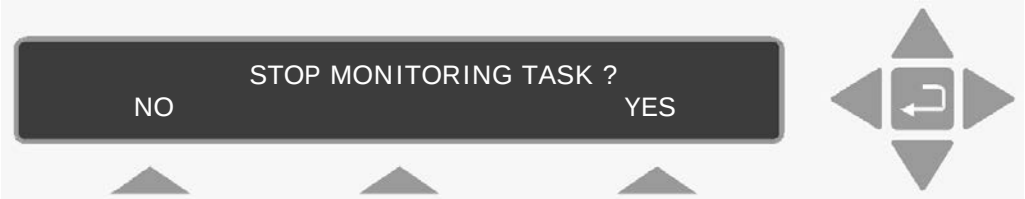
If you do not wish to view the results anymore, press ↵, this acts as a “go to head” function. The following text appears:

A: 7.42E+00	B:_____	C:_____
D: _____	E:_____	W: 8.13+00

4.3.8 Stopping a Monitoring Task

1. Let the Monitor, monitor for a total period of about 30 minutes and then press **MEASURE**.

The following text will appear on the screen:



If you pressed **MEASURE** accidentally, this screen enables you to cancel the request to stop the monitoring task in progress – by pressing **S1**.

2. Press **S3** to stop the task.

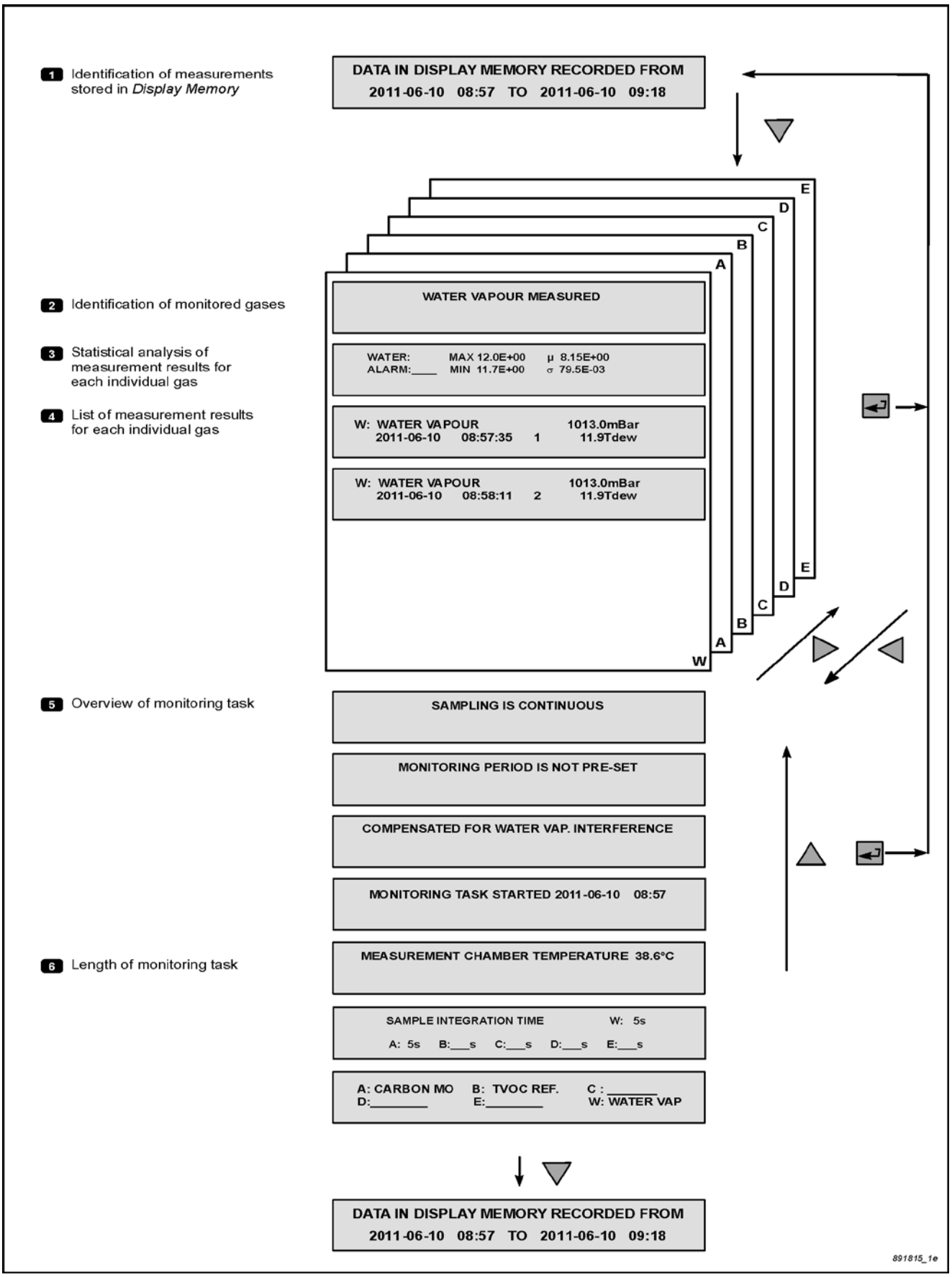
The text, which appears briefly on the screen, indicates that the Monitor is aborting the monitoring task and a summary of the monitoring task will appear on the display as soon as the Monitor has aborted the task. For example:

DATA IN DISPLAY MEMORY RECORDED FROM
2011-01-16 09:50 TO 2011-01-16 10:04

4.3.9 Scrolling through Measurement Results after Completion of a Monitoring Task

All measurement data collected during a monitoring task, is stored in Display Memory together with the parameters which describe the task (a description of the task is given in section 4.3.4).
Using the direction push-buttons, you can scroll through the set-up parameters as well as the individual gas concentration measurements results as explained in section 4.3.7. The organisation of data collected during a monitoring task is illustrated in Fig. 4.4. This illustration also shows the function of the various direction keys. For example, ▶ enables you to move from the measurement results of one gas to the measurement results of another.

Fig.4.4 Organisation of the data displayed on the Monitors screen after completion of a monitoring task


1 Identification of measurements stored in Display Memory
DATA IN DISPLAY MEMORY RECORDED FROM
2011-06-10 08:57 TO 2011-06-10 09:18
2 Identification of monitored gases
3 Statistical analysis of measurement results for each individual gas
4 List of measurement results for each individual gas
WATER VAPOUR MEASURED
WATER: MAX 12.0E+00 μ 8.15E+00
ALARM:____ MIN 11.7E+00 σ 79.5E-03
W: WATER VAPOUR 1013.0mBar
2011-06-10 08:57:35 1 11.9Tdew
W: WATER VAPOUR 1013.0mBar
2011-06-10 08:58:11 2 11.9Tdew
A
B
C
D
E
W
5 Overview of monitoring task
SAMPLING IS CONTINUOUS
MONITORING PERIOD IS NOT PRE-SET
COMPENSATED FOR WATER VAP. INTERFERENCE
MONITORING TASK STARTED 2011-06-10 08:57
6 Length of monitoring task
MEASUREMENT CHAMBER TEMPERATURE 38.6°C
SAMPLE INTEGRATION TIME W: 5s
A: 5s B:___s C:___s D:___s E:___s
A: CARBON MO B: TVOC REF. C : _____
D:_____ E:_____ W: WATER VAP
DATA IN DISPLAY MEMORY RECORDED FROM
2011-06-10 08:57 TO 2011-06-10 09:18
891815_1e

1. Press ▼ and ▶.

The following text appears on the display:

WATER VAPOUR MEASURED

The displays which follow, indicate the type of text which appears each time ▼ is pressed:

WATER:	**MAX 8.55E+00**	**μ 8.15+00**
ALARM 1	**MIN 7.01E+00**	**σ 816E-03**

This is the statistical report of the monitored gases/vapours displayed when the monitoring task is complete. In this case where:

MAX = maximum concentration of water vapour measured during the **whole** monitoring task.

MIN = minimum concentration of water measured during the **whole** monitoring task.

ALARM 1 = the user-defined concentration of water vapour which, if measured by the Monitor, will trigger a switch in the Monitor and activate an external alarm relay connected to it.

μ = linear average, or mean value, of all the water vapour concentrations measured during the **whole** monitoring task.

σ = standard deviation of water-vapour's concentrations from the mean value (μ) described above (see section 9.2.1 for further details).

The humidity unit in this case is Tdew because this is the unit chosen in the **active** set-up (see section 4.3.2).

W: WATER VAPOUR:			**971.88mBar**
2011-01-16	**09:51:33**	**1**	**7.49Tdew**

W: WATER VAPOUR:			**971.88mBar**
2011-01-16	**09:51:33**	**2**	**7.49Tdew**

As you can see the measurement cycles are numbered sequentially as soon as the monitoring task has been stopped for example, the above measurement was made at 09:51:33 on the 16th of January and it was the **second** measurement cycle of the monitoring task. The concentration of water vapour is given in the units of Tdew because this was the unit chosen for humidity in the **active** set-up.

After scrolling through the list of individual measurement results for water vapour the following screen displays appear:

SAMPLING IS CONTINUOUS

MONITORING PERIOD IS NOT PRE-SET

COMPENSATION FOR WATER VAP. INTERFERENCE

MONITORING TASK STARTED 2011-01-16 09:50

MEASUREMENT CHAMBER TEMPERATURE 39.6°C

SAMPLE INTEGRATION TIME				**W: 5s**
A: 5s	**B:___s**	**C:___s**	**D:___s**	**E:___s**

A:Carbon monoxide	**B:_____**	**C:_____**
D: _____	**E:_____**	**W: WATER VAP**

DATA IN DISPLAY MEMORY RECORDED FROM 2011-01-16 09:50 TO 2011-01-16 10:04

Note that the screen showing the overview of gas concentrations measured during any particular measurement cycle is no longer shown when the monitoring task has been stopped.

2. Press ▶.

This causes the following text to appear on the screen:

FILTER A USED TO MEASURE **(the name of the gas being measured by Filter A will appear here)**

3. Press ▼ to scroll through the following data displays:

GAS A:	**MAX 84.5E+00 μ 8.03+00**
ALARM 1_____	**MIN 7.42E+00 σ 2.36E+00**

A: (the name of the gas being measure by Filter A will appear here)		**972.06 mBar**
2011-01-16	**09:50:32 _____**	**7.42 mg/m3**

A: (the name of the gas being measure by Filter A will appear here)		**972.06 mBar**
2011-01-16	**09:51:33 _____**	**7.43 mg/m3**

Press ▶ so you can scroll through the list showing water-vapour's results.
If you do not wish to view the results anymore, press ↵, this acts as a "go to head" function.

4.3.10 Changing Gas-concentration Units after a Monitoring Task

The unit mg/m^3 was chosen for gas concentrations in the monitoring task, which was set up in section 4.3.4. As long as mg/m^3 is the **active** concentration unit (that is, the unit selected while operating in Set-Up mode), this is the unit which will be used to express gas concentrations on the display screens of the PC and the Monitor. It is also the unit when print-outs of monitoring task data are made from the Monitor. However, the user can express the measured gas concentrations in ppm:

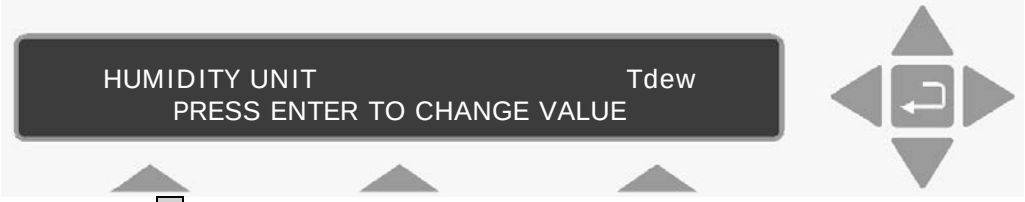
1. Press **SET-UP** **S3** **S2** **S3** and then **SET-UP**.

2. Use ▼ to scroll through the results of the monitoring task no. 1 displayed on the screen. Notice that the gas concentration units have been changed to ppm.

In a similar way the humidity unit for water vapour and the pressure unit can be changed.

4.3.11 Changing the Humidity Unit after a Monitoring Task

1. Press **SET-UP** **S3** **S2** and then ▼ to reach the following display:



2. Press ↵ and use the direction keys to display ppm.

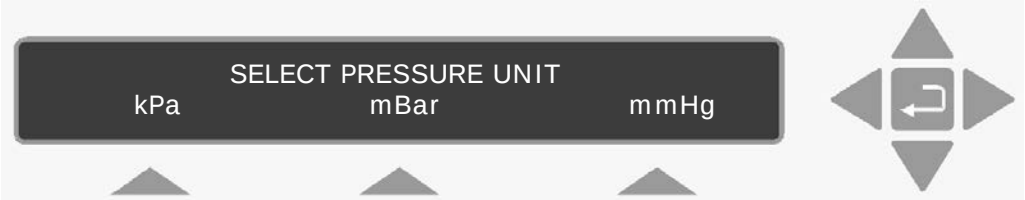
3. Press ↵ to accept the unit of ppm.

4. Press **SET-UP**.

Use ▼ to scroll through the results of the monitoring task no. 1 displayed on the screen. Notice that the water vapour unit has been changed to **ppm**.

4.3.12 Changing the Pressure Unit after a Monitoring Task

1. Press **SET-UP** **S3** **S2** and then ▼ to reach the following display:



2. Press **S3** to accept the unit of mmHg.

3. Press **SET-UP**.

Use ▼ to scroll through the results of the monitoring task no. 1 displayed on the screen. Notice that the Pressure unit has been changed to mmHg.

Chapter 5

The Monitor

October 2012

5.1 Introduction

This chapter is primarily for those users who want to use the monitor as a stand-alone instrument. But the start-up and alarm relay sections are also of interest for the PC user.

5.2 Front Panel

The front panel of the monitor is dominated by a 2 x 40 character fluorescent display screen, 3 **Select** push-buttons located beneath it and 5 **direction** push-buttons (see Fig. 5.1). The rest of the push-buttons, situated in a line along the bottom, are **function** push-buttons.

Fig.5.1 The front panel of the 1314i

Small light-emitting diodes (LEDs) are mounted above some of the front-panel push-buttons. Their function is to inform you of the operating state of the monitor. For example, if the LED above the **MEASURE** push-button is lit, it indicates that the Monitor is either busy performing measurements or has been set-up to start measurements at a pre-defined time.

5.2.1 Direction Push-buttons

This group of 5 push-buttons is referred to in this manual as the direction push-buttons.

▲ & ▼ have two uses: to increase & decrease numbers, respectively, or to go to the Previous & Next Displays, respectively.

The number increase and decrease functions are used whenever values, which can be changed manually, are displayed on screen, for example, changing a parameter such as the length of sampling tube.

The “Previous Display” and “Next Display” functions are used when you want to view the previous or next screen texts. This can be useful when setting up the monitor. By using these push-buttons, you can scroll quickly through a branch of the Set-Up Tree. These push-buttons can also be useful when viewing measurement data, for example, if you are looking at gas A’s measurement result no.3 – by pressing ▲, gas A’s measurement result no.2 will be shown on the screen. By pressing ▼, gas A’s measurement result no.4 will appear on the display screen.

◄ & ► enable you to move across number fields or go to the Previous & Next gases, respectively.

When you are entering values or names in the monitor, for example when setting up the monitor, you can use these push-buttons to move the cursor across the entry fields.

“Previous Gas” & “Next Gas” functions, are used primarily when viewing measurement data. The display screen only displays the measurement data for one gas at a time (out of 5 gases and water vapour). These push-buttons allow you to look at the measurement data for any one of the 4 other gases and water vapour (see Fig.4.4 and section 4.3.9).

↵ Depending on the situation, this push-button acts as either an “Enter” or “Go To Top of Measurements” function.

The “Enter” function is used whenever measurement units are selected or any text, for example filter names or gas names, are being entered. The Monitor display will typically display a text similar to PRESS ENTER TO CHANGE VALUE.

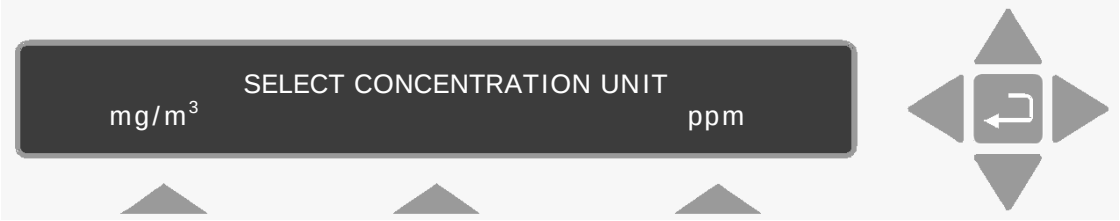
The “Go To Top of Measurements” function is used in the following situations:

- If you are viewing measurement data, when ↵ is pressed, the display will move to the screen showing the text DATA IN DISPLAY MEMORY RECORDED FROM... which gives the period of time data was recorded – see Fig.4.4 for details.
- If the Monitor is performing measurements when ↵ is pressed, the Monitor will display the last measured concentrations of all the gases.

5.2.2 The Select Push-buttons

Located below the text display screen, these three push-buttons, allow you to select from the pre-defined options appearing on the display screen. The following example illustrates the use of the select push-buttons:

If the text on the screen appeared as follows:



a. By pressing **S1** the gas concentrations which appear in the measurement results will be quoted in mg/m^3.

b. By pressing **S3** the gas concentrations which appear in the measurement results will be quoted in ppm.

5.2.3 Function Push-buttons

The order of these push-buttons are the same as they are seen on the front of the monitor.

RESET By pressing this push-button you can choose the type of reset the Monitor should perform. For further details see section 5.3.

LOCK This push button enables setting up three different password protected User Levels. For further details see section 2.7.

MEASURE In this mode you are able to choose the type of measurement the Monitor should perform, and decide when the measurement should start.

MEMORY In this mode you are able to store measurement data in the *Background memory* of the monitor, as well as recall or delete data from the *Background memory*.

INFO This push-button has two functions. It allows you to perform the following two functions:

- Acknowledge any message, which may appear on the display screen during operation of the Monitor.
- Obtain more detailed information about the condition of the Monitor at any particular moment of time, if such information exists.

PRINT By pressing this push-button, measurement results in the *Display memory* of the Monitor can be printed out. The lamp above this push-button is lit, while measurements are being printed and the display will show PRINTING MEASUREMENT DATA until all data has been printed out.

SET-UP In this mode you are able to enter the Set-Up Tree of the Monitor. In set-up **mode,** the user is able to program the Monitor to perform almost any kind of measurement, and amongst other things; enter data about the optical filter(s) which are installed in the Monitor; select different measurement parameters; choose how measurement results should be formatted in print-outs; choose the interface and communication codes which are necessary to print data; set the internal clock of the Monitor and choose the self-tests the Monitor should perform.

When the **Talk/Listen** LED is lit, this means that there is activity on one of the interfaces.

5.3 Starting-up or Restarting the Monitor

5.3.1 Introduction

When the monitor is started up in the normal way, that is, by switching on the AC Mains power-switch on the back panel, the monitor responds by performing a **partial reset**. A **partial reset** is also performed if during operation the monitor is switched off and is re-started in any of the following ways:

- If the Monitor stops operating due to an AC mains power failure and then re-starts itself (automatically) when power is restored to it;
- If the user stops operating the Monitor by switching it off using the AC mains power switch on the back panel, and then re-starts it by using the same switch:

Users can also "partially reset" the Monitor by using the **RESET** push-button on the front panel (see section 5.2.3).

5.3.2 A Partial Reset of the Monitor

When the Monitor performs a **partial reset** a number of self-tests are automatically performed. The types of tests performed depend only upon the time, which has elapsed since the Monitor was last switched on.

- If **more** than 10 mins. have elapsed since the Monitor was switched on it will perform the **software**, **data-integrity**, and **hardware** tests when switched on again.
- If **less** than 10 mins. have elapsed since the Monitor was switched on it will perform only the **data-integrity** tests when switched on again.

There are essentially 3 types of self-tests which can be performed during a "partial reset" – a **software** test, a **data-integrity** test and a **hardware** test.
It takes the Monitor only a few seconds to perform the **data-integrity** tests; and about 3 minutes to perform both the **software** and **hardware** test. The different tests are explained below.

Software test

This test checks the information in the Monitor's software (ROM – **R**ead **O**nly **M**emory.)

Data-integrity test

This test checks the integrity of the data stored in the Monitor's Source Memory (i.e. its EEPROM – **E**lectrically **E**rasable **P**rogrammable **R**ead **O**nly **M**emory) and the integrity of the data stored in the Monitor's ***Working Memory*** (RAM).

Hardware test

This test checks that the electrical, mechanical and electronic parts of the Monitor are functioning properly.
The following parts of the Monitor are checked: the pump; the valves in the pneumatic system; the infra-red light source; the power supply; the filter carousel; the motor which drives the chopper wheel; the external vibration level (to make sure that it does not contribute to the signal measured in the analysis cell);

the analogue circuitry and the microphones (to check that they are functioning properly).
If you do not wish the Monitor to perform the **hardware** test during a partial reset, you can disable it (see section 5.4.3). This also disables the regular self-tests.

If any part of the Monitor is found to be functioning incorrectly a message will appear in the display to inform the user of the problem. For example:

The user must acknowledge receipt of such a message by pressing **INFO**. Operating errors and warning messages are listed in table-form in Chapter 17 at the end of this manual.

If a fault is found in any of the blocks of data stored in the ***Working Memory***, the Monitor will automatically set the parameters in the relevant compartment(s) to their default values, and the Monitor will send the following message on its display screen:

WARNING: MEMORY SET TO DEFAULT
ERROR DETECTED IN XXXXX MEMORY

Where XXXXX denotes the part of the memory that has been affected. When such a message is received users must check the contents of the relevant memory to find out which data has been affected before continuing to operate the Monitor.

5.3.3 Response of the Monitor after a Partial Reset

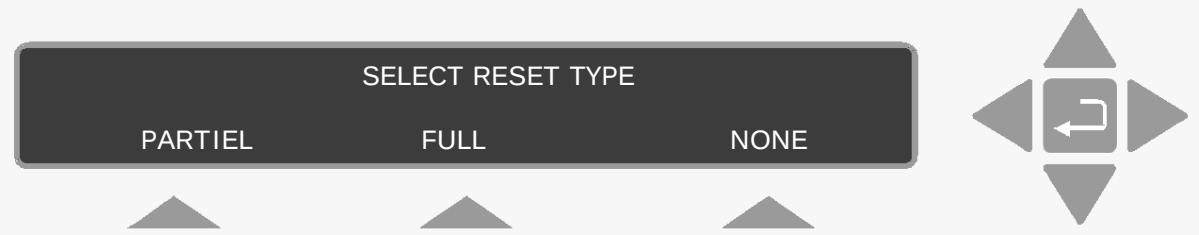
The way in which the Monitor responds after a **partial reset** is dependent upon the way it was being operated at the time of the partial reset (see Table 5.1). For example, if the Monitor was busy taking a measurement when it was "partially reset" it will complete the interrupted measurement after the partial reset, continue its monitoring task and make a special "mark" alongside the first complete measurement cycle it performs after the reset. These "marks" are described in section 9.2.2 and section 9.2.3.

Table 5.1 Dependence of Monitor's response, after a partial reset, to its operating condition at the time of the partial reset.

Monitor last used while in…	**Task being performed**	**Task started after a PARTIAL RESET**
Measurement **mode**	A gas measurement	Completes the monitoring task
"Display"	Looking at measurement results on the display screen	Measurement results are shown on the display from the beginning again
Set-up **mode**	Changing set-up parameters which control the operation of the Monitor	Measurement results are shown in the display from the beginning
Memory **mode**	Handling measurement results which are stored in Display Memory and Background Memory	Completes any interrupted task and then measurement results are shown in the display from the beginning
"Interface"	Obtaining hard-copies (that is, print-outs of, for example, measurement data)	Print-out is stopped and measurement results are shown in the display from the beginning

5.3.4 Full reset and/or Partial Reset of the Monitor via its Front Panel

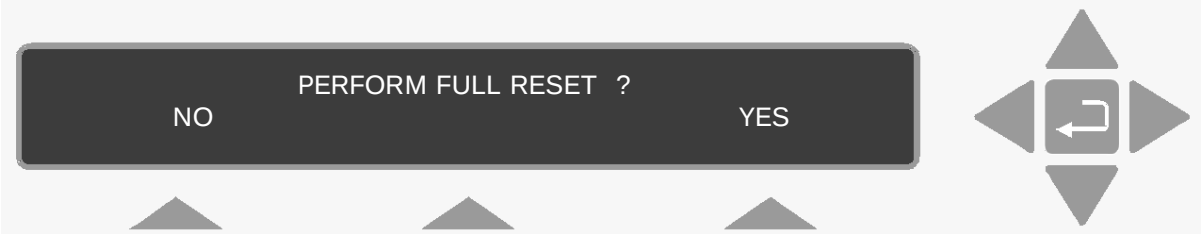
There are two well-defined levels of reset. By pressing **RESET** the following text appears on the display screen:



If **S3** is pressed, you can come out of reset mode without performing any kind of reset. The Monitor just goes back to operating the same way it was operating before the **RESET** push-button was pressed.

S1 **PARTIAL** Reset: If this level of reset is chosen the Monitor stops operating, performs a **partial reset** as described in the previous section (section 5.3.2) and then resumes operating in the fashion described in Table 5.1.

S2 **FULL** Reset: If this level of reset is chosen the Monitor responds by changing the text on the display so that you have a chance to **confirm** that you wish the Monitor to perform a **FULL** reset:



S1 By pressing this push-button the user can come out of reset **mode** without performing any kind of reset. The Monitor just goes back to operating the same way it was operating before **RESET** was pressed.

S3 By pressing this push-button the user confirms that a **FULL** reset is required. During a **FULL** reset the Monitor performs the following two tasks:

- "Clearing" (emptying) all data from its ***Working Memory***. This means all data in ***Display Memory*** and ***Background Memory*** will be lost.

- Copying data from its ***Source Memory*** into its ***Working Memory***. This means that set-up parameters in block 3 of ***Working Memory*** "Other Set-up Parameters" will be given their **default** values, and the values of the optical filter set-up parameters in ***Working Memory*** will be the same as those found in ***Source Memory***.

5.4 Configuring the Monitor

5.4.1 Setting the Clock

Before dispatch from the factory, the internal clock of the Monitor is set to the correct local (Danish) time.

The current date is entered as Year-Month-Day for example the 24th of July 2011 is entered as 2011-07-24.
The current time is entered as the time on the 24-hour clock for example 14:05 is five minutes after two in the afternoon. Table 5.2 details the range of acceptable values and the default value of the date and time.

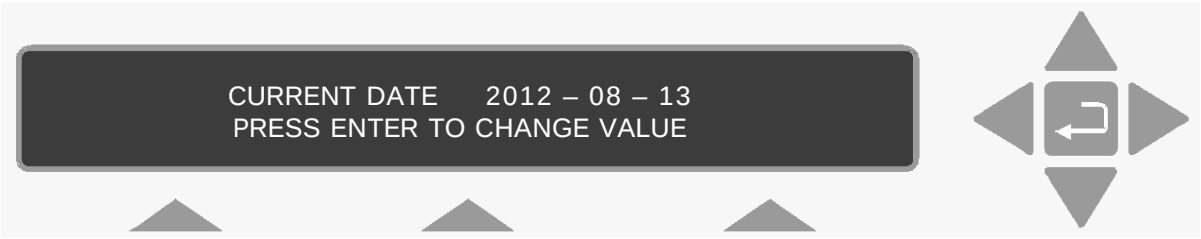
Table 5.2 The range of acceptable values and the default value of the date and time

Display Text	Acceptable Values	Default Value
ENTER CURRENT DATE 0000-01-01	0000-01-01 to 9999-12-31	1988-01-01
ENTER CURRENT TIME 12:47	00:00 to 23:59	12:00

If the Monitor is to be used as a stand-alone instrument, then the clock can be adjusted to your local time using the following instructions.

1. Press **SET-UP**.
   Refer to the Set-Up Tree diagram, so that you can follow your progress through the various branches of this set-up.

2. Press **S3** **S1** **S1** **S1**.
   The following screen picture appears:



3. To change the date, press ↵.

4. Use the direction push-buttons to enter the correct date. If you make a mistake, press **S1** to revert back to the original date.

5. Press ↵ to accept the date.
   This causes the text on the display screen to change to the following:

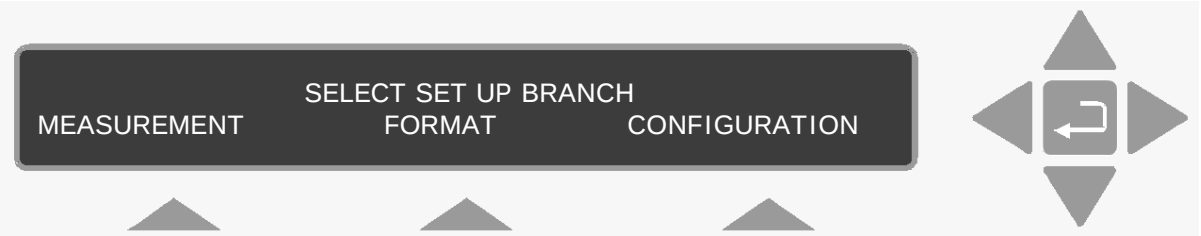
6. To change the time, press ↵.

7. Use the direction push-buttons to enter the correct time. If you make a mistake in entering the correct date just press **S1** and start again.

8. Press ↵ to accept the time.

When Step 8. has been completed the display then moves to the **previous** head of the set-up "tree".

9. Press ▲ three times. The screen display shows the following text:



10. Press SET-UP to exit the set-up function.

5.4.2 Adjusting the Sound Level

During certain operations or, for example, when an incorrect push-button is pressed, the Monitor emits a "beep". You choose the volume of the Monitor's "beep". The volume of the "beep" is expressed on a scale from 0 (no "beep") to 3 (loudest "beep"). Table 5.3 provides details of the available choices and the default value of this parameter.

Table 5.3 The available choices and the default value of the Monitor's "beep"

Display Text	Available Choices	Default Value
ENTER SOUND VOLUME 0	0, 1, 2, 3	1

To set the volume:

1. Press **SET-UP**.

2. Press **S3** **S1** **S1** **S2** .
   The following screen picture appears:

3. To change the volume, press ↵.

4. Use the direction push-buttons to enter the correct volume. If you make a mistake, press **S1** to revert back to the original volume.

5. Press ↵ to accept volume.

6. Press **SET-UP** to exit the set-up function.

5.4.3 Enabling / Disabling Self Tests

If you do not wish the Monitor to perform regular self tests, including the **hardware** test on power-up you can disable it.

1. Press **SET-UP** **S3** **S1** **S1** **S3**

2. Press **S1**, the Monitor no longer performs the **hardware** test as part of its self-testing procedure during any kind of reset.

3. Press **SET-UP** to exit the set-up function.

5.5 Alarm Relay

Two alarm relays are built into the **alarm relay** socket on the back panel of the Monitor. The function of the pins in this female connector are shown in Fig.5.2. The two alarm relays can be connected to a variety of either audio (for example, a siren) and/or visual (for example a flashing light) alarm systems and they are activated whenever a pre-defined concentration (alarm level) of one (or more) of the gases being measured is exceeded. Alarm signals are given by opening and closing the relay contacts.

Both relays are closed when the Monitor is switched off and when the Monitor is switched on. This means that there is a direct electrical connection between pins 1 & 2 and pins 4 & 5 at all times except when the Monitor measures a gas concentration which is greater than the corresponding alarm limit for the gas. When this concentration is measured, the Monitor breaks the connection between pins 1 & 2 or 4 & 5. The monitor will furthermore activate the internal beeper and write the following message on the display:

WARNING:
ALARM LIMIT EXCEEDED

The user can switch off the beeper and the message by pressing **INFO** or **RESET** push-button on the front-panel of the Monitor.
The alarm relays will continue being activated until either (1) **all** measured gas concentrations fall below their user-defined alarm level(s); or (2) the monitoring task is stopped – this automatically closes the alarm relays.

Alarm Relay 1:

Alarm Relay 1: correspond to High Alarm Limit 1.

Whenever one or more gases exceed their alarm level(s) for high alarm limit 1, the Monitor breaks the electrical connection between pins 1 & 2 and this activates the attached alarm system.

Alarm Relay 2:

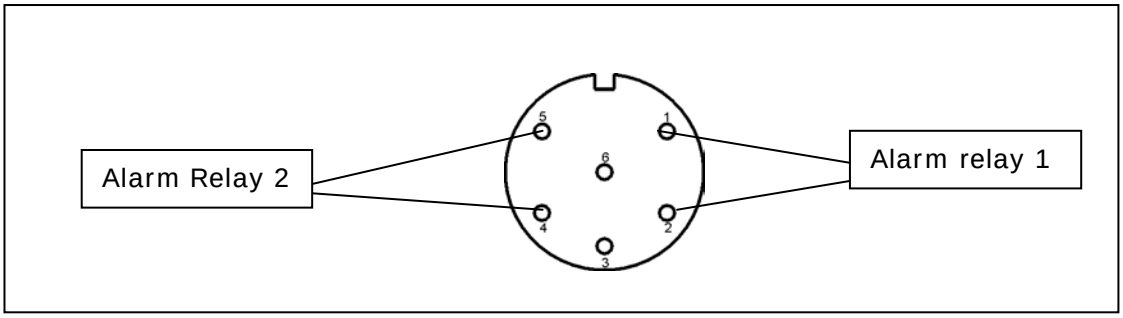
Alarm Relay 2: correspond to High Alarm Limit 2.

Whenever one or more gases exceed their alarm level(s) for high alarm limit 2, the Monitor breaks the electrical connection between pins 4 & 5 and this activates the attached alarm system.

LumaSense supplies a 6-pin DIN plug (male) with a locking collar JP0600 for connecting external alarm devices to the alarm relay.

Caution:
The DC voltage across the relay contacts must not exceed 25V. The potential on the relay contacts must not be more than 25VDC above chassis potential, as this will cause an excessive leakage current. The current through the contacts must not exceed 100mA. AC voltages must not be connected to the Alarm Relay socket.

Fig.5.2 Configuration of the pins in the alarm relay socket



5.6 Continuous Warm System

The Continuous Warm System ensures that the monitor is kept warm at any time that is also when the Monitor is not measuring.

If the Monitor is powered up at all time you can save the warm up time when starting a measurement.

5.6.1 Setting-up the Monitor to Continuous Warm System

The procedure to enable the Continuous Warm System is as follows:

1. Press the following push-button sequence: **SET-UP** **S3** **S1** **S1**, and the following text is displayed:

SELECT GENERAL SET-UP BRANCH ?		
CLOCK	SOUND	TESTS

2. Press **S3** **▼ three times** **S3** **SET-UP**. This selects the continuous warm system.

3. Press **RESET** **S1** (Partial Reset) in order to enable the continuous warm system

Chapter 6

Keying-in Parameters

October 2012

6.1 Types of Parameters

There are four types of parameters:
Numerical: you are free to enter the desired values. However, there may in many instances be a range in which your values must lie. These ranges can be found in the relevant sections of this manual.
Text: you are able to type user-defined text, for example, the names of the gases you are measuring and when using the PC the names of your databases.
The characters available to you when using the monitor on its own are shown in the table below:

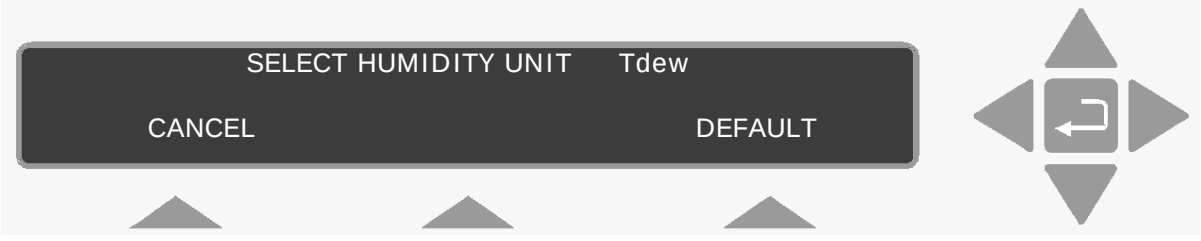
Fig.6.1 The characters which are available for gas names

Characters available for Gas Names
▲ → AaBbCcDdEeFfGgHhIiJjKkLlMmNnOoPpQqRrSs TtUuVvXxYyZz_' ". , : ; &!?@ | ^ # $ \ % / + - ( ) { } [ ] < > Ø 1 2 3 4 5 6 7 8 9 AaBbCc etc ←▼

Pre-defined: you are able to select a parameter using the "select" push-buttons when there are three or less options, or by scrolling through a pre-defined list using the direction push-keys. The parameters in the lists are given in more detail in the relevant sections of this manual.
Current Time: in the monitor is synchronized to match the time and date of the internal clock in the PC when the two are connected together. However, it is possible to adjust the monitors date and time using the front panel push-buttons. This is described in full in section 5.4.1.

Stand-alone Use

Whenever you are choosing parameters and/or "entering" parameter values via the front-panel push-keys, two options are available:



CANCEL This option appears over the **S1** select push-button. If you change the value of a parameter on the display screen and then decide that the new value is not correct, the original parameter can be brought back to the screen by pressing **S1**.

Default This option appears over the **S3** select push-button. If you wish the parameter appearing on the display screen to be the same as the factory-defined value you can press **S3**.

Some parameters do not have pre-defined **default** values, so that when **Default** is used a blank line will appear instead of a number. The **default** value of such a parameter is said to be "blank". For example:

GAS A'S HIGH ALARM LIMIT 1_____ppm
CANCEL DEFAULT

If the value of a chosen parameter lies outside the pre-defined minimum and maximum values the value will be corrected and, at the same time, a "*beep*" will sound. You will then have to "enter" the correct value by pressing ↵ and repeating the process.

When you have to choose or change a parameter, and the text **PRESS ENTER TO CHANGE VALUE** is displayed, use the direction push-buttons and follow the procedure below. Details about the direction keys are provided in section 5.2.

1. Press ↵. A cursor will *blink* under one of the parameter's numbers or letters and the bottom line will display the soft-keys **Cancel** and **Default**.

2. Use ▲ and ▼ to change the entry above the cursor to the desired number, letter. For pre-defined parameters, these push-buttons enable you to scroll through the list. Display the desired parameter, then go to step 5.

3. Use ◄ and ► to move the cursor across the entry fields and repeat step 2.

4. Repeat steps 2 and 3 until the entry fields show the desired value or text.

5. Press ↵.

If the parameter you desire is already selected (i.e. a cursor is displayed under it), then using ▼ enables you to move directly to the next display.

These procedures are common for all the parameters in the Monitor.

Chapter 7

Setting-up and Starting a Monitoring Task

October 2012

Before a measurement task can commence, there are a variety of parameters that *must* be defined first. This is called “Setting up the Monitor”.

This chapter instructs you on how to set up the monitoring system before starting to measure. As mentioned previously in this manual, the parameters can be defined using the PC Use instructions, i.e. when using a PC, or the stand-alone Use instructions, i.e. when using the front panel push-keys on the monitor.

Before leaving the factory, each of the parameters found in the set-up “tree” (see the Quick Set-up Guide) are given factory values (**default values**).

When setting-up the Monitor as a stand-alone instrument, those values with a cursor underneath them are the **active values**. It is the **active values,** which determine how the Monitor will operate.

Warning! Failure to define any parameter may result in the default parameters being used. This can result in the monitor measuring incorrectly or being unable to start the measurement task.

7.1 The Parameters’ Units

The Monitor works internally with measurement parameters in SI units. These units can be converted and displayed as a variety of other measurement units. Defining the units here has two uses. It enables you to set-up the measurement parameters using familiar units and displays the measurement results with the desired concentration units.

These parameters are listed below.

Table 7.1 The possible parameter units and the default settings

Parameters	Units	Default Unit
Humidity	mg/m^3, ppm, Tdew, kPa	mg/m^3
Pressure	mbar, mmHg, kPa	kPa
Temperature	°C, °F, K	°C
Gas Concentrations	mg/m^3, ppm	mg/m^3
Length	m, ft	m

The units for existing measurement results can also be changed using these instructions.

Normalization Temperature

If you have chosen to measure gas concentrations in the unit mg/m3, you must “enter” the temperature at which the Monitor should calculate gas concentrations. If, for example, you “enter” a normalization temperature of 25°C, the measured gas concentrations, which appear on the display during a monitoring task will be calculated in mg/m3 units at **25°C**. The acceptable values and the default values of the normalization temperature are given in Table 7.2 in the different temperature units.

Table 7.2 The acceptable values and the default values of the normalization temperature

Display Text	Acceptable Values	Default Value
NORMALIZATION TEMPERATURE	0°C, 20°C and 25°C	20°C
NORMALIZATION TEMPERATURE	32°F, 68°F and 77°F	68°F
NORMALIZATION TEMPERATURE	273K, 293K and 298K	293K

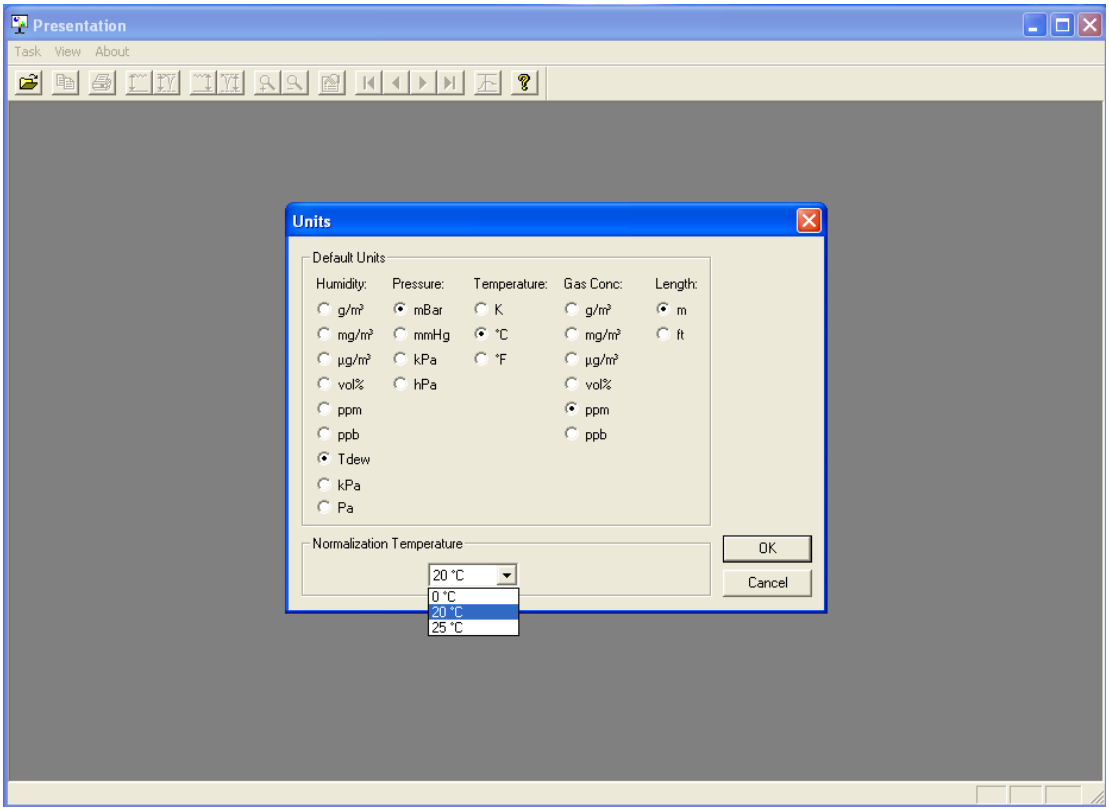
If you set up the monitor using the front panel push-buttons, the instructions to set the normalization temperature are included in the section 7.1.1.

7.1.1 Offline Unit Set-up

With the Offline program running:

1. Click on the **Units** soft key at the bottom of the dialogue box. The Units dialogue appears, see Fig. 7.1.

Fig.7.1 The Units dialogue



2. Click on the radio push-buttons to select the desired units.

3. If you have selected the mg/m^3 unit for the gas concentration, click in the *Normalization Temperature* field.

Note these temperature values change depending on the temperature units selected, i.e. °C, °F and K.

4. Select the desired value and click on **OK**.

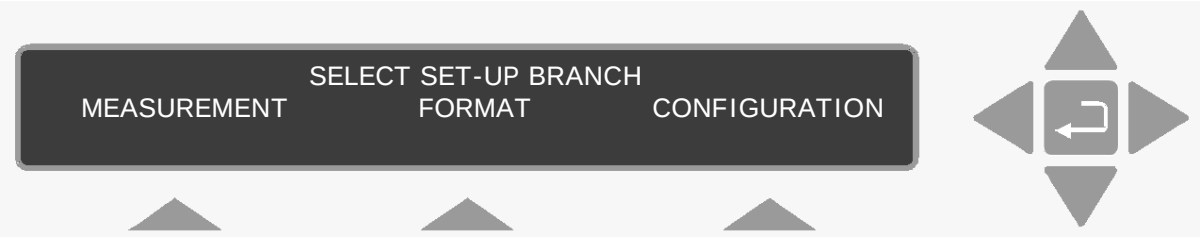
All the parameters' units are now set.

7.1.2 Stand-alone Unit Set-up

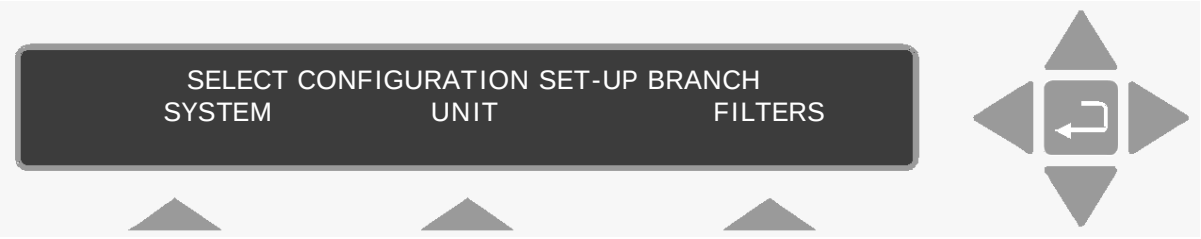
For those of you setting up the monitor using these instructions, it may be useful for you to follow the steps taken using the Set-Up Tree.

The philosophy of the instructions is described in section 3.3.

To enter at the top of the Set-Up Tree, press **SET-UP** and the monitor displays the following screen text.



1. Press **S3** to enter the **CONFIGURATION** branch. The new text displays three branches.



Units branch

2. Press **S2** to enter the **Units** branch.

3. Use the select push-buttons to define the concentration unit.

4. Use the select push-buttons to define the length unit.

5. Use the select push-buttons to define the temperature unit.

6. Use the select push-buttons to define the pressure unit.

7. The humidity unit is displayed. Use the direction push-buttons to change it to the correct value.

When step 7 is completed the display returns to the top of the **Units** branch.

Press ▲ to go to the top of the Set-Up Tree, or press **SET-UP** to exit the set-up mode.

7.2 The Measurement Parameters

The list of parameters to be defined is long. To help show where these parameters appear in the Gas Monitoring software 7304, the parameters are grouped under their index card name.
The information about the parameters and the ranges shown is also valid for those of you setting up the Monitor using the front panel push-buttons.

Sampling index card

Sampling mode: the manner in which the gases are sampled. There are two possibilities here:

Continuous sampling: once the monitor is finished measuring it starts again making the next measurement, for a full explanation see section 4.1.

Interval Sampling: this is the time from the start of one measurement cycle to the start of the next one, for a full explanation see section 4.1.

Table 7.3 The range of acceptable values and the default value for the Fixed interval sampling

Acceptable Values hours:minutes	Interval hours:minutes	Defalut Value hours:minutes
00:01 to 01:00	00:01	00:02

Flushing: the length of time the monitor flushes the measurement chamber and the sample tubing between measurements. There are two options here:

Auto: the monitoring system controls the flushing by selecting the optimum flushing time. This time can vary as this option takes into account the cleanliness of the external air-filters and the length of the sampling tube.

Therefore, the sample tube length must be defined.

Table 7.4 The acceptable values and the default values of the length of the sampling tube

Monitor Display Text	Acceptable Values	Default Value
LENGTH OF SAMPLING TUBE	0 – 99 metres	0.00
LENGTH OF SAMPLING TUBE	0 – 324.90 feet	0.00

Fixed Time: there are two selections here: Chamber, which is always selected with this option and Tube. See Table 7.5 for the acceptable values.

Table 7.5 The range of acceptable values and the default values for the chamber and sample tube flushing times

Acceptable Values	Interval	Default Value
Chamber: 2 to 60 s Tube: 0 (=off), 3 to 120 s	1 s 1 s	8 s 3 s

Water Interference: the Monitor is capable of measuring water's contribution to the signal measured in its analysis cell. The user can decide whether or not the signal should be compensated for water's contribution. It is suggested that water should be compensated for in all measuring situations except where extremely dry gases are being measure.

Cross Interference: if any "interferent" other than water vapour is present in the ambient air-sample, the Monitor can cross compensate for the interference caused by its presence provided that a selective optical filter is installed in the monitor to measure the concentration of interferent gas present.

Gas index card

Gas Setup: there are up to six selections here: A, B, C, D, E and W. These represent the filters installed in the monitor's filter carousel. When setting up a new monitoring task, you can choose freely between the gases available for each filter (names entered when calibrating the filters, see sections 14.3 and 14.5). Once a gas has been selected for a filter and the measurement task started, you can no longer change the gas for this filter in this measurement task. However, you can still select gases for filters, which have not previously been used in the measurement task.

Note: only one gas per filter can be selected at a time for measuring. The W position always represents the water filter installed in the monitor.

Sample Integration Time: this enables you to make a choice between speed and accuracy. Generally, the longer the integration time the more accurate the results. There are several selection possibilities here:

Integration Type	Integration Time
Fast	1 s
Normal	5 s
Low Noise	20 s
Advanced	0.5s, 1s, 2s, 5s, 10s, 20s, 50s

Alarm index card

Select Gas: this option enables you to select any of the gases (one per filter position) already defined in the set-up.
Limit: enables you to define the gas concentration that will trigger the alarms. The acceptable values are shown in Table 7.6.

Select limits: this defines the concentration level when the alarm is triggered. This parameter must be defined.

Table 7.6 The range of acceptable values and default value of the alarm limit for the gases

Display Text	Acceptable Values	Default Value
GAS A HIGH ALARM LIMIT 1 n* _____PPM	0-1000000ppm	Blank
GAS A HIGH ALARM LIMIT 1 n* _____mg/m3	Depends on the molecular weight of the gas	Blank

n* = A to W

Instantaneous/Rolling Average: (PC use – *Online only*) these are toggle functions, only one of these can be selected. The Rolling Average option enables you to prevent the alarm being triggered by sudden, small fluctuation in the gas concentrations by using values, which are averaged over a defined period of time. The averaging time is defined in minutes. The acceptable values are: 1 to 999 mins, and the default value is 10 mins.

Action: this provides you with 4 ways to trigger the alarm. One or more of the options can be selected simultaneously.

PC Beep: when an alarm is triggered the PC makes a beeping noise.
Monitor Beep: when an alarm is triggered the monitor makes a beeping noise.
Monitor Relay 1 & Monitor Relay 2: selecting these options enable you to connect the alarms to a variety of either audio (for example, a siren) and/or visual (for example a flashing light) alarm systems.

Active Alarms: only the gases, which you have selected and activated, are shown in this field.

7.2.1 Measurement Set-up – 7304 Off-line PC Use

In the new window there are several labelled “index card” separators. Each index card contains several parameters.

Sampling index card

1. Click on the radio-button for the desired sampling mode. If Sample Interval is selected, set the time to the correct value.

2. Click on the radio-button for the desired flushing mode.
   a. If Auto is selected, set the correct tube length
   b. If Fixed Time is selected, set the desired chamber flushing time and the tube flushing time.

3. If water vapour and cross interference are required, click in the appropriate check boxes.

4. If average values are to be displayed on the gas monitors screen, click in the Average check box, and set the interval to correct value.

Gas index card

5. Click on the “Gas” index card.

6. Click in the check box to the left of the desired filter.

7. Click in the field to the right of the selected filter and select the correct gas.

8. Repeat steps 10. & 11. until all the filters which are required for the measurements are selected and the correct names are displayed.

9. Click in the *Sample Integration Time* field and select the desired option.

10. (Advanced settings only). Note that a new field has appeared to the right of the gas names. Click in the field and define the times for the selected filters.

Alarms index card

11. Click on the “Alarms” index card

12. Click in the *Select gas* field to display the list of gas names.

13. Click on the desired gas name.

14. Click in the *Select Limit* field, and type in the desired concentration.

15. Click on **Add New** or **Insert Before** if you want to insert the new entry at the top of the list.

16. Repeat steps until all the required alarms are set.

Note: if you wish to remove an alarm, select the gas in the *Alarms*: field and click on **Remove**.

Up/Download index card – Offline Only

17. Click on the Up/Download index card

18. Click on the **Download Settings** soft key. This will download the settings in the Sequence Settings dialogue to the monitor.

19. When the transfer is complete, Click on the **Close** soft key to exit the Offline program.

You are now ready to start measuring, see section 7.4.

7.2.2 Measurement Set-up – Stand-alone Use

The philosophy of the instructions is described in Chapter 3.

To enter the Set-Up Tree, press **SET-UP** and the monitor displays the following screen text.

1. Press **S1** to enter the **MEASUREMENT** branch. The new text displays two branches.

Monitoring Task branch

2. Press **S1** to enter the Monitoring Task branch.
   The following text is displayed:

3. Up to 10 different monitoring tasks can be defined here. These are labelled from 1 to 10. Use the direction push-buttons to select the desired set-up number and move on to the next display.

4. Use the select push-buttons to define if you want to sample continuously:
   If you select No (**S1**), go to step 5.
   If you select Yes (**S3**), go to step 6.

5. The sampling interval is displayed. Use the direction push-buttons to change it to the correct value.

6. Use the select push-buttons to define if you want to monitor for a pre-set period:
   If you select Yes, go to step 7.
   If you select No, go to step 8.

7. The monitoring period is displayed. Use the direction push-buttons to change it to the correct value.

The **MONITORING PERIOD** is entered as Days Hours: Minutes. For example, if this particular measurement cycle needs to be performed during 5 days, 14 hours and 30 minutes, the "monitoring period" should be "entered" as 5 14:30. The Monitor will then automatically stop monitoring 5 days, 14 hours and 30 minutes after the measurement cycle with this particular set-up number is started. The range of acceptable values and the default value of the monitoring period is shown in Table 7.7.

Table 7.7 The range of acceptable values and the default value of the monitoring period

Display Text	Acceptable Values	Default Value
ENTER MONITORING PERIOD	**days** **hours: minutes** 0 00:01 to 7 00:00	**days** **hours: minutes** 0 01:00

The Monitor's Display Memory has finite storage capacity. The data storage time available depends upon the number of gases being measured, as well as the frequency with which measurements are performed (that is, the sampling interval). Section 9.3 provides information about how you can roughly calculate the length of time the data from a particular monitoring task can be stored in the *Display Memory*.

It is important to realise that once the *Display Memory* has been filled up by the results of a particular monitoring task, the results

of any further measurements in the same monitoring task will start to overwrite the data already stored in the memory.

8. Use the select push-buttons to define if you want to compensate for water vapour interference.

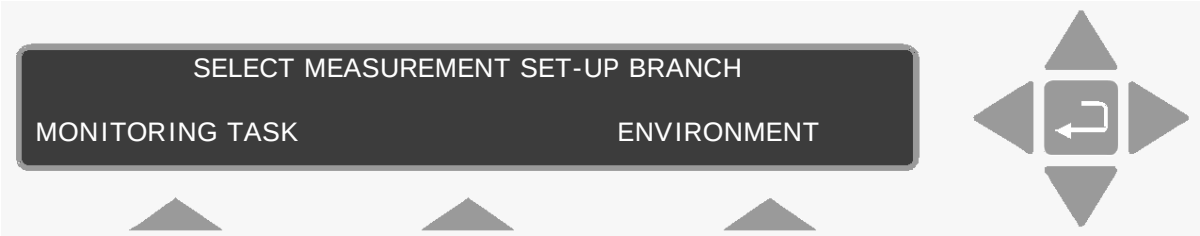
9. Use the select push-buttons to define if you want to cross compensate for interferents.

10. Use the select push-buttons to select the filters/gases you want to measure. This step can be repeated up to 5 times, if 5 filters are installed.

11. Use the select push-buttons to define if you want to measure water vapour.

12. Use the select push-button to define if you want to store the measurement history.

When step 12 is completed the display returns to the top of the branch.



Environment branch

13. Press **S3** to enter the Environment branch.

14. Use the select push-buttons to select the desired flushing mode.
If you select Auto, go to step 17.
If you select Fixed Time, go to step 15.

15. Use the direction push-buttons to define the Chamber Flushing Time.

16. Use the select push-buttons to select Tube Flushing.
If you don't want tube flushing, select NO and go to step 18.
If you select tube flushing, use the direction push-buttons to define the flushing time and go to step 18.

17. Use the direction push-buttons to select the desired sample tube length and move on to the next display.

18. Use the direction push-buttons to select the desired normalization temperature.
    See section 7.1 for details about the normalization options.

When step 18 is completed, the display returns to the top of the **MEASUREMENT** branch.

Press ▲ to go to the top of the Set-up Tree.

If you want measurement data presented as averaged concentration values, then go to step 20. If you want your measurement data presented as sample concentration values, then press **SET-UP** to exit the set-up function.

Format branch

If you are starting here, press **SET-UP**:

19. Press **S2** to enter the **FORMAT** branch.

20. Use the direction push-buttons to enter the correct averaging period.

21. Use the select push-buttons to choose if you want to print each gas.
    If you select Yes, go to step 22.
    If you select No, go to step 23.

22. Use the select push-buttons to choose which individual parameters should be printed. Each time one of the select push-buttons is pressed, the next parameter is displayed. This step can be repeated up to 7 times, depending on the number of filters installed.

23. Use the select push-buttons to select the Text line Terminator.

24. The text screen returns to the top of the set-up tree. Press **SET-UP** to exit the set-up tree.

If you want to set Alarm limits for the measured gases, go to section 7.3.

7.3 Setting-up the Monitor's Alarm Levels

The alarm limits of a gas are those concentrations of gas which should activate any alarm relay connected to the Monitor via its back panel "**Alarm Relay**" socket. There are two different alarm relays, which function slightly differently. Details of these relays and the way in which they function is described fully in section 5.5. The alarm level parameters are found in the **Filters** branch of the Set-Up Tree.

Warning! If the UA number for any filter is changed here, then all the calibration data for that filter will be lost and the filter will need to be recalibrated.

1. Press **SET-UP** **S3** **S3**. The following text is displayed

CHECK AND / OR CHANGE SET-UP FOR FILTER A
NO YES

2. Use the select push-buttons to ignore this filter or to select this filter if alarms are to be set.

3. Press ▼ 5 times until the following text is displayed.

GAS A HIGH ALARM LIMIT 1 _____ mg / m³
PRESS ENTER TO CHANGE VALUE

4. Use the direction push-buttons to set the alarm concentration.

   If you do not wish to activate the alarm function for a particular gas, select the **DEFAULT**. This will "blank out" the alarm level value for the gas and deactivate the alarm for that gas.

GAS A HIGH ALARM LIMIT 2 _____ mg / m³
PRESS ENTER TO CHANGE VALUE

5. Repeat steps 2 to 4 to set the alarms for the other filters.

6. Press **SET-UP** to exit the alarm set-up.

7.4 Starting a Monitoring Task

Monitoring tasks can be started in two ways. They can be started immediately, or set to start at a pre-set time. The duration of the monitoring sequence can also be determined. A monitoring task can continue until it is stopped manually, or at a pre-set time.

When using the PC and the Online option, there are no limits to the duration of a monitoring task. However, if the measurement results are being stored in the monitor's memory, the duration of the monitoring task should be considered as there is only a finite amount of memory in the monitor. See section 9.3 for full details about the storage capacity of the monitor.

7.4.1 PC Use – using the Online Program7810 Application SW

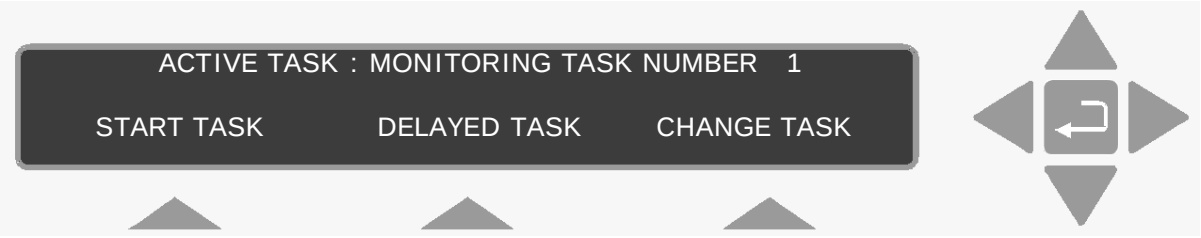
Please refer to user manual BE6027 for Application Software 7810 for assistance to set-up start and stop a monitoring task.

7.4.2 PC Use – using the 7304 Offline Program

Before a monitoring task is started, the monitor should be warmed up and set-up, as described in section 7.2, must be completed and downloaded from the 7304 Offline program to the monitor.

1. Press **MEASURE**.

The following text appears on the screen:



Please note: if you do not use one of the "select" keys within a short time after the above text appears, the Monitor will automatically stop operating in **Measure** mode (the light-emitting diode in the **MEASURE** key switches off). If this happens, just press **MEASURE** again.

2. To start the measurement immediately, press **S1**.
   To delay the start, press **S2**.

The following warning then appears on the display:

Display Memory is where the Monitor stores the results of all measurements while it is performing a monitoring task. If the monitoring task is stopped and then started again all the data already collected will be deleted from *Display memory.* However, the data in Display Memory can be copied into and stored in the Monitor's *Background Memory*. This operation is described in section 11.2.

3. Press **S1**.

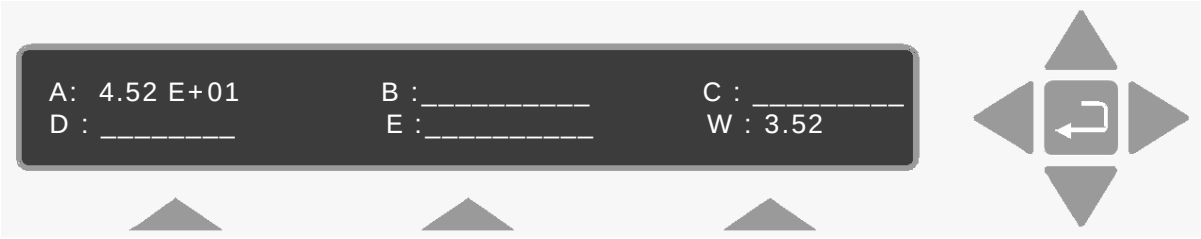
Immediate Start

If you selected an immediate start, the following text appears on the screen:

MEASUREMENT IN PROGRESS
RESULTS NOT YET AVAILABLE

4. When the first measurement cycle is complete the Monitor will automatically display the results and update them every time a new measurement cycle is completed.

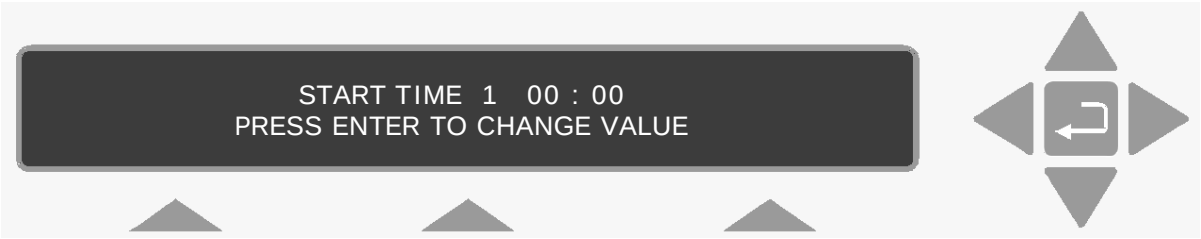
An example is shown below:



This display gives the overview of the gas/vapour concentration last measured – in this case the concentration of gas A and humidity of the water vapour are in the units that were selected – that is mg/m^3 for gas A and Tdew for water vapour (see section 4.3.2).

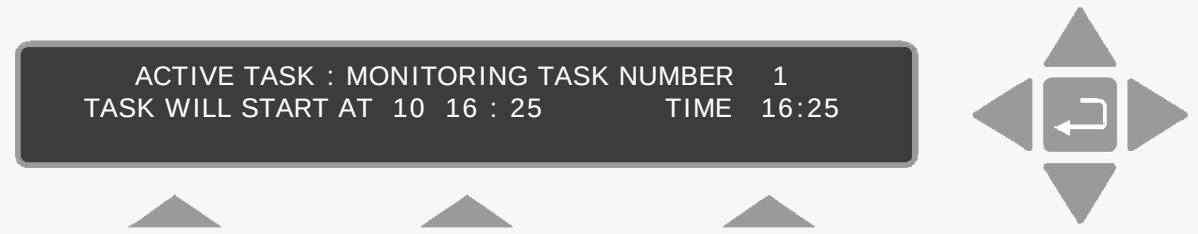
Delayed Start

If you selected a delayed start, the following text is displayed:



Press ↵

The following text is displayed.



The time shown in the TIME: field is the current time.
The measurement task will start at 10 16:25. At 16:25 the 10th of the Current month. When the monitoring task starts, the monitor's screen will change and display the same messages as those displayed when a monitoring task starts immediately.

Stopping the Monitoring Task

If no pre-set monitoring period is defined, then to stop the monitoring task, press **MEASURE** and **S3**.

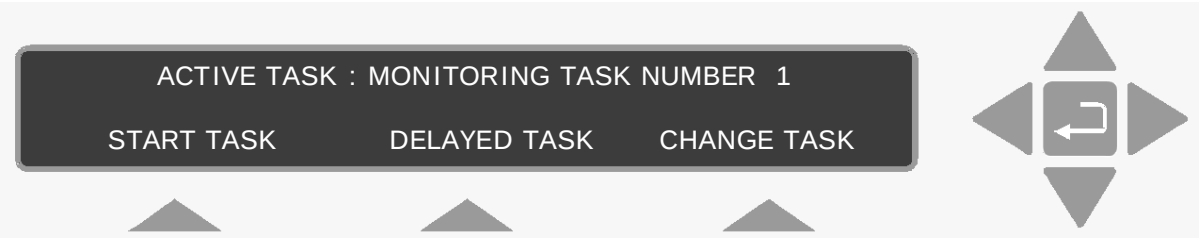
7.4.3 Stand-alone Use – using the Front Panel Push-buttons

Before a monitoring task is started, the set-up, as described in section 7.2, must be completed:

Before any monitoring task is started, all data stored in the Monitor's *Display Memory* is removed (cleared). The *Display Memory* is where the Monitor stores the results of all measurements while it is performing a monitoring task. However, the data in *Display Memory* can be copied into and stored in the Monitor's *Background Memory*. This operation is described in section 11.2.

When you start a new monitoring task the following warning is displayed **WARNING: DISPLAY MEMORY WILL BE DELETED** to remind you to store any data that is presently stored in the *Display Memory*. If a monitoring task is stopped, any data already stored in *Display Memory* will be deleted when a monitoring task is started.

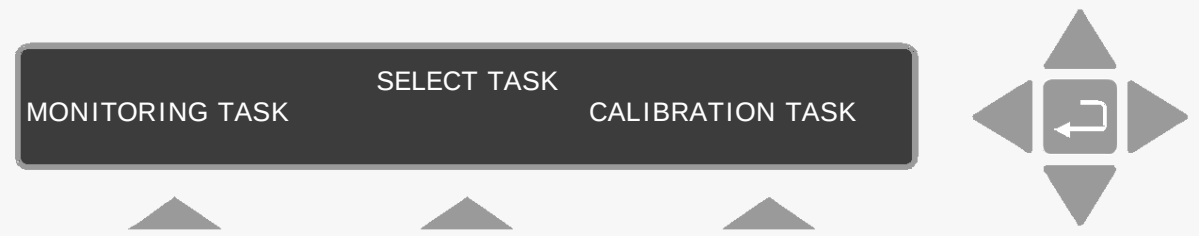
1. Press **MEASURE**.
   The following text appears on the screen:



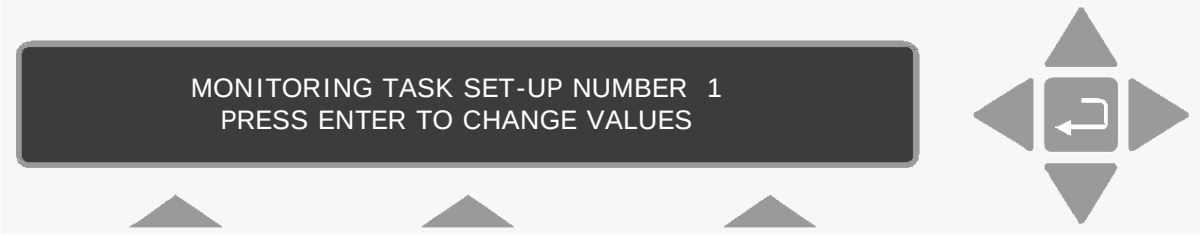
Please note: if you do not use one of the "select" keys within a short time after the above text appears, the Monitor will automatically stop operating in **Measure** mode (the light-emitting diode in the **MEASURE** key switches off). If this happens, just press **MEASURE** again.

The **active** monitoring task number is the number of the monitoring task you wish the Monitor to perform.

2. If the monitoring task number displayed is correct, then go to step 5.
   If the number on the display is **not** correct then press **S3** to change the task number.
   This changes the display text to the following:

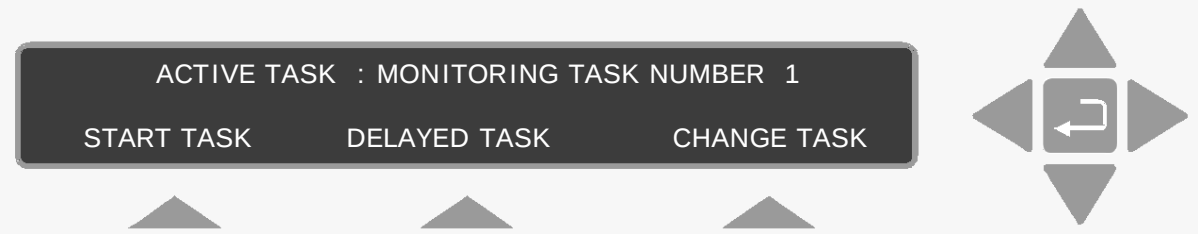


3. Press **S1**.
   This causes the following text to appear on the display:

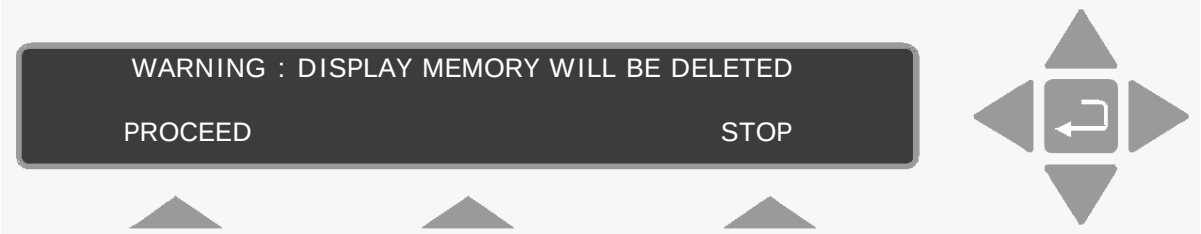


The number appearing on the screen will be a number from 1 to 10.

4. Press ↵ and use the direction keys to change the monitoring task number to the desired value. Then press ↵ again to accept the task number.
   The following text appears on the display screen:



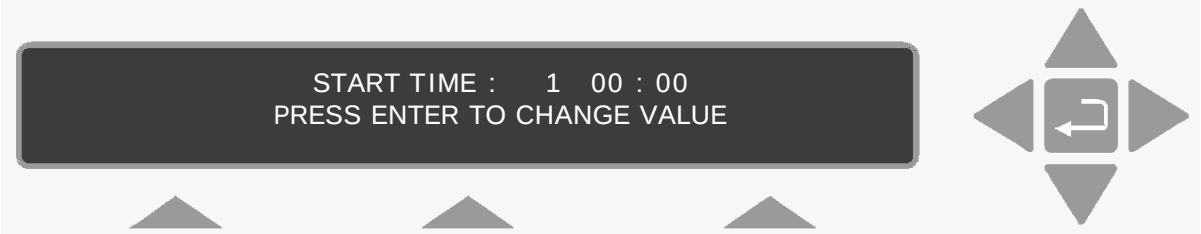
5. To start the measurement immediately, press **S1**.
   To delay the start, press **S2**.
   The following warning then appears on the display:



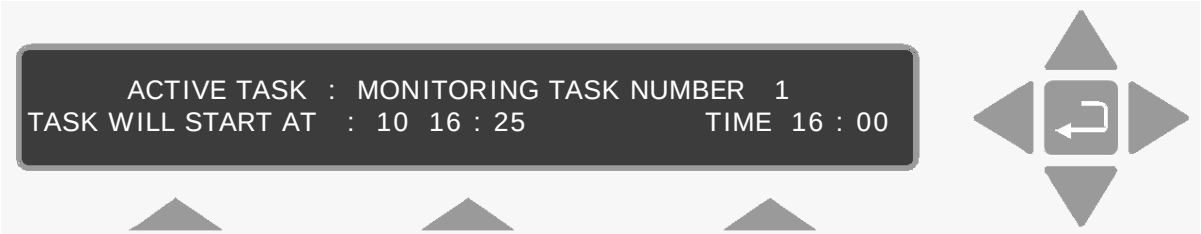
1. Press **S1**.

Delayed Start

If you selected a delayed start, the following text is displayed:



Use the direction push-buttons to enter the desired date and start time, e.g. 10 16:25. The following text is displayed.



When the monitoring task starts, the screen will change and display the same messages as those displayed when a monitoring task starts immediately.

Immediate Start

If you selected an immediate start, the following text appears on the screen:

MEASUREMENT IN PROGRESS RESULTS NOT YET AVAILABLE

2. When the first measurement cycle is complete the Monitor will automatically display the results and update them every time a new measurement cycle is completed. An example is shown below:

This display gives the overview of the gas/vapour concentrations last measured – in this case the concentration of gas A and humidity of the water vapour are in the units that were selected – that is mg/m^3 for gas A and Tdew for water vapour (see section 4.3.2).

If no pre-set monitoring period is defined, then to stop the monitoring task, press **MEASURE** and **S3**.

Chapter 8

Viewing Measurement Data – using a PC

October 2012

8.1 Measurement Data from the monitor's internal memory

In order for the measurement data to be viewed using the 7304 PC software, the data must be stored in the PC. For Stand-alone use, where the measurement data is stored in the monitor, then the data must be Uploaded to the PC using the 7304 Gas monitoring Software.

All measurement data from the Monitor, regardless of what is being displayed on screen during the measurement is transferred to the PC and stored in a MS-Access® format. This measurement data can be viewed on screen, analysed and used in other software programs that utilize ODBC.

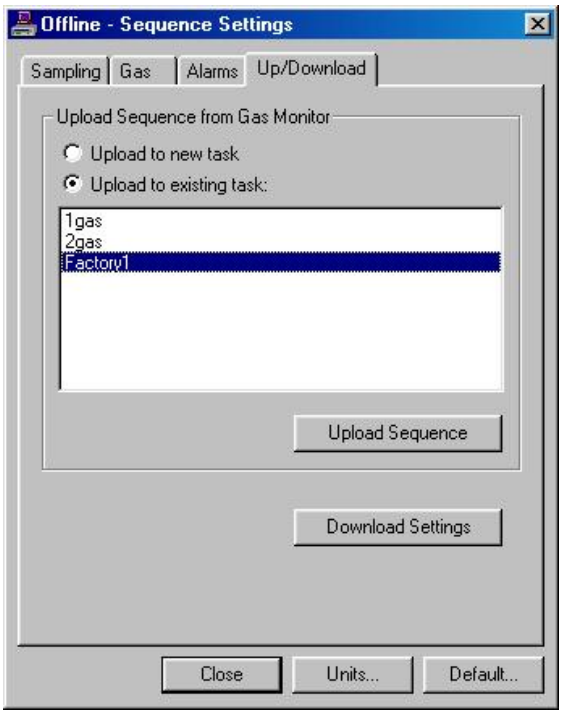
8.1.1 Uploading Measurement Data from the Monitor

Any measurement data that is stored in the Monitor's display memory can be uploaded to a PC. Measurement data can be uploaded either as a new measurement task, which is given a unique name, or it can be uploaded so that it becomes a sequence in an existing measurement task. If something happened while monitoring, the uploaded data retains these marks, which can be displayed using the Presentation program.

With the monitor and the PC connected as described in section 2.2 and the Offline program running:

1. Click on Up/Download index card, see Fig.8.1.

Fig.8.1 The Up/Download dialogue



2. Click on the radio-button to either Upload to a new task or Upload to an existing task.

If you are adding data to an Existing Task, select the monitoring task from the list displayed.

3. Click on the **Upload Sequence** soft-key.

If you are uploading measurement to a New Task, a New measurement Task dialogue opens, type in the desired monitoring task name now, and click on **OK**.

The measurement data is uploaded to the PC, where it can be viewed using the Presentation program.

If the upload sequence soft-key is activated when no data is stored in the Monitor's display memory the following warning will be displayed. (Fig. 8.2).

Fig.8.2 Offline warning message.

8.2 Graphic Window

This window can display all the measured gases and atmospheric pressure, simultaneously. The concentration curves can be allocated to either of the two axes. The scale and units of these axes can be set individually to suit the displayed value on them. The number of curves displayed, their colour and their styles are defined by you. Measurement data can be displayed as instantaneous concentration curves or as average concentration curves, where you define the averaging interval. This window also displays several “MARKS”. These appear if something happens during the measurement, or an alarm is triggered. These marks can be hidden with the Presentation program. See “Events” index card in section 8.2.1 and section 8.3.1.

8.2.1 Graphic Window Properties Dialogue Box

This dialogue box enables you to define exactly what is displayed in the graphic window. The separate sections are divided up by index cards. To simplify matters, the following explanations are given under the index card name headings.

Interval index card

This index card is divided into several groups:

Measurement Sequence: this option is only available when the **Presentation** software option is used. You can select any one of the sequences recorded under the currently selected monitoring task.

Time: this is a toggle option. You can select either this option or the measurement number option. This option enables you to define the X-axis as a period of time.

Note there are slight variations here between the Online program and the Presentation program.

Measurement Number: this is a toggle option. You can select either this option or the Time option. Like the time option, by defining a value here, you define the length of the X-axis, defined as a number of measurements. For the presentation option, several measurement sequences, under the same monitoring task name, can be displayed at the same time.

Rolling Average: this enables you to define what sample values are displayed. If the check box in this field is *not* ticked (default setting), then individual sample concentration values are displayed. However, if the check box is ticked an averaging interval must be entered

Rolling Average: the individual sample values are averaged and displayed on the graph. By defining the averaging time, you can display defined Time-weighted Average (TWA) values. This can be of use if you need to know 8 hour National Occupational Exposure Limits or Short Term Exposure Limits (STEL) averaged over 15 minutes. The formulae used to calculate the average values are described in detail in section 8.4. The units of the value defined here change depending on which radio-button was selected, time or measurement number.

Left Y-axis index card

It is here you define the scale of the left Y-axis, which curves are allocated to this axis, and their appearance.

Scaling: this enables you to set the scale of this axis. There are three possibilities:

Autoscale maximum and minimum: by selecting this option, the measurement data will always be displayed. The scale will start just below the minimum value and end just above the maximum value.

Autoscale maximum (minimum = 0): by selecting this option, the axis will always start at zero. The top value depends on the maximum value

Autoscale OFF: this option enables you to define the minimum and maximum values on the axis. This can be of use if you are interested in a particular range. Note that with this option, the curve(s) may not appear on the screen. When you select this option, the scaling icons in the tool bar become active.
These icons enable you to change the scaling:

0 to maximum or minimum to maximum, respectively.

Single Curve Setup: it is here you define which gas curves are allocated to this axis. You define their colour, the style of line, you can even change their units here if necessary.

Select parameter: by clicking in this field, the names of all the gases and the atmospheric pressure measured during this monitoring task are displayed. Clicking on a parameter name enables you to set up the curves individually.

Select colour: there are seven standard colours to choose from. If necessary, a user-defined colour can be selected. By clicking on **Define**, the Windows® mixing palette is displayed. The standard Windows procedure should be followed.

Select style: there are several styles to choose from. These are displayed by clicking in the style field.

Select unit: this enables you to display the gas or pressure with the desired units. When you click in the select unit field, the units available for this gas or pressure are displayed.

All Curves: if a curve for a measured value is to be displayed in the graphic window, then it must appear here. Gases and the atmospheric pressures are entered in this field by first displaying their name in the *Select Parameter* field, setting up the display parameters for the curve and then pressing the **Add New** soft-key. Note that if a parameter already appears here, but you want to edit one or more of the display parameters, then you must remove the existing parameter and add it with changed display parameters.

Soft-keys: these three keys are used to edit the names in the *All curves* list.

Add New: if this is pressed after the appearance of a gas and the atmospheric pressure has been defined, then the gas is added to the end of the list of gases already displayed.
Insert Before: this puts the selected parameter at the top of the list.
Remove: this enables you to remove a curve name, resulting in this curve not being displayed.
Note: the fastest way to set type Y-axis in the graphic window is: when the sequence settings are defined, open a new graphic window. All the selected parameters are displayed. If you want to change any of the display parameters, then do this using the Windows Properties dialogue.

Right Y-axis index card

It is here you define the scale of the right Y-axis, which curves are allocated to this axis and their appearance.
All the values in this index card are set up in exactly the same way as those in the Left Y-axis index card.

Event index card (presentation only)

There are five check boxes that can be selected here. If a tick appears in the check box, then this “event” is displayed in the graphic window.

Communication Errors: are marked by a line with a “C” at the end of it. These indicate when a communication error has occurred between the monitor and the PC.

Alarms: are marked by a line with a small red triangle at the end. These indicate when the alarm was triggered, and which gas triggered the alarm.

User Events: are marked by a cursor with a User event Text at the top of it.

Gas Monitor Warnings/Errors:

Event Marks	Description
Common Marks: apply to all filters	
"P"	The Monitor stopped measuring due to a power failure, but automatically re-started monitoring again after regaining power. The Monitor was "reset" because a fault was detected.
"W"	An operational error was detected, or a warning was given during the measurement. The accuracy of the measurement cannot be guaranteed.
Gas Marks: apply to individual filters	
"B"	The Monitor was incapable of calculating this gas concentration.
"F"	After this measurement the filter carousel was found to be out of alignment. If the misalignment is only slight, then accuracy of the measurement has not been affected, but the accuracy of such a measurement cannot be guaranteed.
"▼"	The gas concentration measured during this measurement cycle exceeded the user-defined alarm limit, resulting in an alarm being triggered.
To see which gas the Common Mark adheres to, open a numeric window.	

8.3 Numeric Window

This window can display all the measurement data, simultaneously. Gas Measurement data can be displayed as instantaneous values or as average values. This window also displays several "MARKS". These appear if something happens during the measurement, or an alarm is triggered. If any events have been added during the monitoring task, these are also displayed here. These marks and events can be hidden with the Presentation program. See "Events" index card in section 8.2.1 and section 8.3.1.

8.3.1 Numeric Window Properties Dialogue Box

Interval index card

This index card is divided into several groups:

Measurement Sequence: this option is only available when the **Presentation** software option is used. You can select any one of the sequences recorded under the currently selected monitoring task.

Time: this is a toggle option. You can select either this option or the measurement number option. This option enables you to define the column length as a period of time.

Presentation: defining the times and dates here enable you to select a time period, which can stretch over several measurement sequences. In fact, the complete monitoring task can be displayed by defining the times and dates here.

Measurement Number: this is a toggle option. You can select either this option or the Time option. Like the Time option, by defining a value here, you define the length of the column, defined as a number of measurements. For the presentation option, several measurement sequences, under the same monitoring task name, can be displayed at the same time.

Rolling Average: this enables you to define what sample values are displayed. If the check box in this field is *not* ticked (default setting), then individual sample values are displayed. However, if the check box is ticked an averaging interval must be entered:

Rolling Average: the individual sample values are averaged and displayed in the columns. By defining the averaging time, you can display defined Time-weighted Average (TWA) values. This can be of use if you need to know 8 hour National Occupational Exposure Limits or Short Term Exposure Limits (STEL) averaged over 15 minutes. The formulae used to calculate the average values are described in detail in section 8.4.2. The units of the value defined here change depending on which radio-button was selected, time or measurement number.

Columns index card

It is here you define which component's parameters are displayed in the numeric window.

Single Column Setup: you define which parameters are displayed and their units.

Select parameter : by clicking in this field, the names of all the gases and atmospheric pressure measured during this monitoring task are displayed. The gases and pressure are selected individually.

Select unit: this enables you to display the desired units for each gas and for the atmospheric pressure. When you click in the select unit field, the available units for this parameter are displayed.

All Columns: if a component's parameter is to be displayed in the numeric window, then it must appear here. Parameters are entered in this field by first selecting their name and units and then pressing the **Add New** soft-key. Note that if a parameter already appears here, but you want to edit the units, then you must remove the existing parameter and add it again with the changed units.

Soft-keys: these three keys are used to edit the names in the All Columns list.

Add New: if this is pressed after the appearance of a parameter has been defined, then the gas is added to the end of the list of gases already displayed.

Insert Before: this puts the selected parameter at the top of the list.

Remove: this enables you to remove a parameter curve name, resulting in this curve not being displayed.

Note: the fastest way to set the properties in the numeric window is: when the sequence settings are defined, open a new numeric window. All the selected components are displayed. If you want to change any of the display parameters, then do this using the Windows Properties dialogue.

Events index card (presentation only)

There are five check boxes, which can be selected here. If a tick appears in the check box, then this “event” is displayed in the numeric window.

Communication Errors: are marked by a line with a “C” at the end of it. These indicate if there has been communication problems between the Monitor and the PC.

Alarms: are marked by a small red triangle ▼.
These indicate when the alarm was triggered, and are situated on the value for the gas, which triggered the alarm.

8.4 Using the Cursors

Cursors can be used in both the numeric and graphic windows. The way they are used and the information they provide is the same in both situations. Before the cursors can be displayed, the Cursor Values window must be opened and the window in which you wish to position the cursor(s) must be selected. Once the Cursor Values window is open, you click on the curve (in the graphic window) or on the value (in the numeric window) that you are interested in.

The cursor function is divided into two parts: when a single cursor is displayed and when two cursors are displayed.

8.4.1 “Single” Cursor

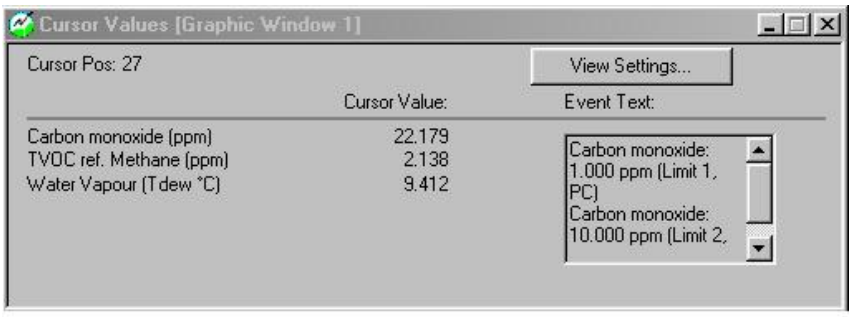
When you click in the window, a single cursor appears in the graphic window while two cursors appear either side of a single value in the numeric window. The Cursor Values dialogue gives several pieces of information:

Cursor Position: this can be given as either a time and date or a measurement number, depending on what was defined in the Window Properties dialogue.

The displayed measurement values (and their display units) are listed on the left-hand side of the dialogue. Opposite each parameter, under the heading Cursor Value, there is a value displayed. This is the measured value for the parameter where the cursor has been positioned.

There is a soft-key, **View Settings**, which enables you to see the measurement’s settings (see section 7.2) for the measurement sequence.

Fig.8.3 The Cursor Value window using a single cursor.

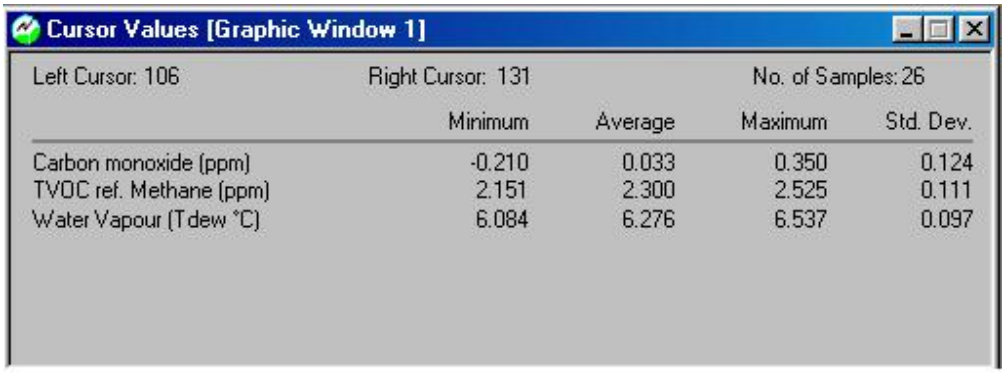

Cursor Values [Graphic Window 1]
Cursor Pos: 27
View Settings...
Cursor Value:
Event Text:
Carbon monoxide (ppm) 22.179
TVOC ref. Methane (ppm) 2.138
Water Vapour (Tdew °C) 9.412
Carbon monoxide: 1.000 ppm (Limit 1, PC)
Carbon monoxide: 10.000 ppm (Limit 2,

Note: the View Settings soft-key is only available when this “single” cursor is displayed.

8.4.2 Two Cursors

If you are interested in the measurement data in a particular range, or need to zoom in, then two cursors can be used. The second cursor is displayed when you click on the initial cursor (either of the cursors in the numeric window), hold the left mouse button down and drag the cursor to the desired position and then release the mouse button. The two cursors are quite easy to see now. The information in the Cursor Values dialogue changes.

Fig.8.4 Cursor Value Window using two cursors.


Cursor Values [Graphic Window 1]
Left Cursor: 106
Right Cursor: 131
No. of Samples: 26
Minimum Average Maximum Std. Dev.
Carbon monoxide (ppm) -0.210 0.033 0.350 0.124
TVOC ref. Methane (ppm) 2.151 2.300 2.525 0.111
Water Vapour (Tdew °C) 6.084 6.276 6.537 0.097

Left Cursor Position: this can be given either as a time and date or a measurement number, depending on what was defined in the Window Properties dialogue.

Right Cursor Position: this can be given as either a time and date or a measurement number, depending on what was defined in the Window Properties dialogue.

The displayed parameters (and their display units) are listed on the left-hand side of the dialogue. Opposite each parameter are several values under the headings:

Minimum: this shows the minimum value for each parameter between the cursors.
Average: this gives the linear average value for all the values for each parameter between the cursors. The calculation of “the mean value” can be expressed mathematically as follows:

$$\text{The average value} = \frac{\sum_{n=1}^{n=N}(Cn)}{N}$$

Where: N = measurement cycles performed during the monitoring period (T) between the cursors.
C_n = gas concentrations (where n = 1 to N)

Maximum: this shows the maximum value for each parameter between the cursors.
Standard Deviation: this is the standard deviation of a particular gas’s measurements from the average value of this parameter.

$$\text{The Standard deviation} = \sqrt{\frac{\sum_{n=1}^{n=N}(Cn-\mu)^2}{N-1}}$$

Where: μ = the mean value
C_n = individual gas concentrations
N = total number of measurements

Note: the **View Settings** soft-key is not displayed when two cursors are displayed.

Zoom Function

When two cursors are displayed, the zoom function can be used. By pulling down the **View** menu and clicking on **Zoom in**. All the measurement data outside the cursors is removed from the screen. By setting new cursors, the zoom can be repeated.

Note: the Cursor Values dialogue updates each time the new cursors are displayed.

There are two ways to zoom out again.

You can pull down the **View** menu and click on **Zoom out**.

or

You can redefine the time “window” or the number of measurements displayed in the Window Properties dialogue.

8.5 User Event Markers

If something happens or you change something during a monitoring task, or you just want to indicate a measurement for some reason, this is possible using the Insert User Event option. The measurement results are marked by a vertical line with a Keyed in User Event Text at the top in the graphic window and a horizontal line with the event text at the end of it in the numeric window.

At the cursor: this is only possible when the cursor is displayed. The marker appears at the cursor, but remains there after the cursor is moved. This is the only way to insert User Events when using the Presentation program.

When the presentation option is used to view measurement data, the user event markers can be displayed or hidden, depending on the settings in the Window Properties dialogue (see section 8.2.1 and section 8.3.1).

8.5.1 Inserting a User Event Marker

If you want to insert a User Event marker at the cursor, position the “single” cursor.

1. Pull down the **Edit** menu. Click on **User Event** and a new dialogue box opens.

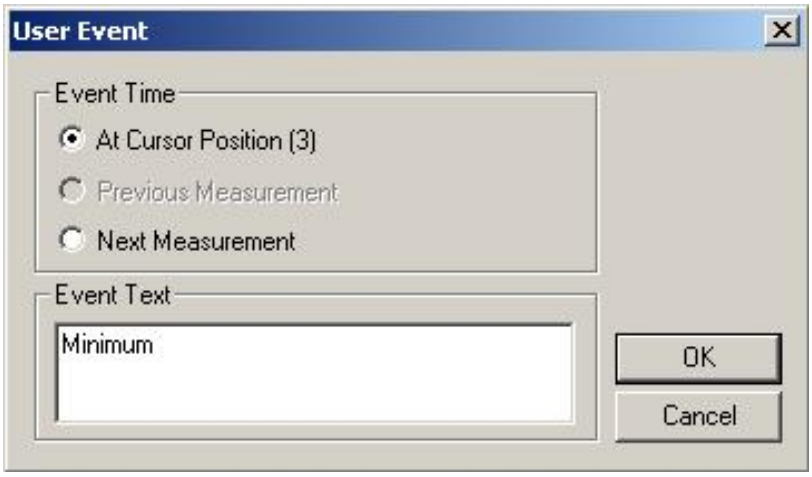
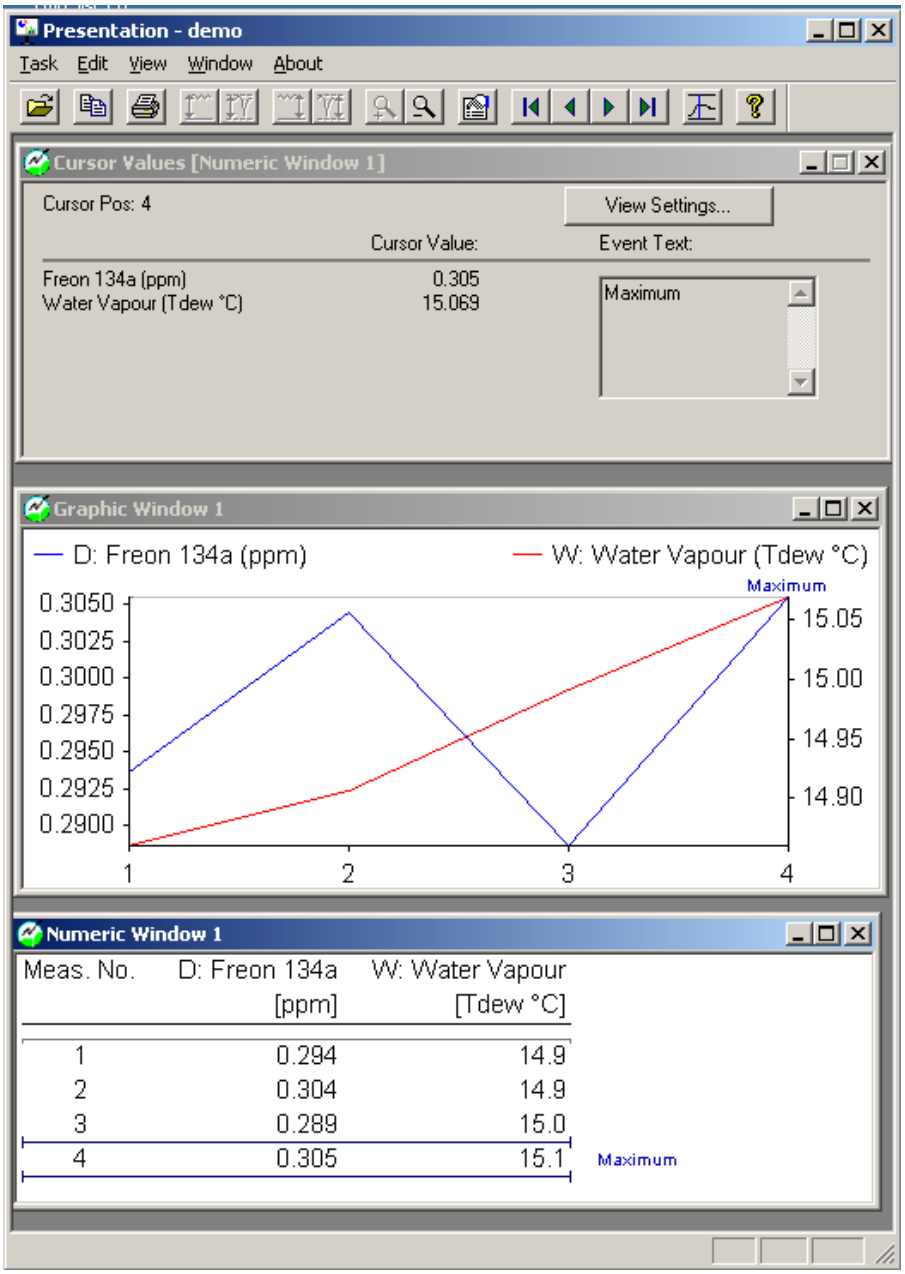


Fig.8.5 The User Event window.

2. Type in any comments you may have in the Events Text field.

3. Click on **OK**.

Fig.8.6 The User Event text in the graphic and numerical windows.



The user event marker and event text will appear at the designated point.

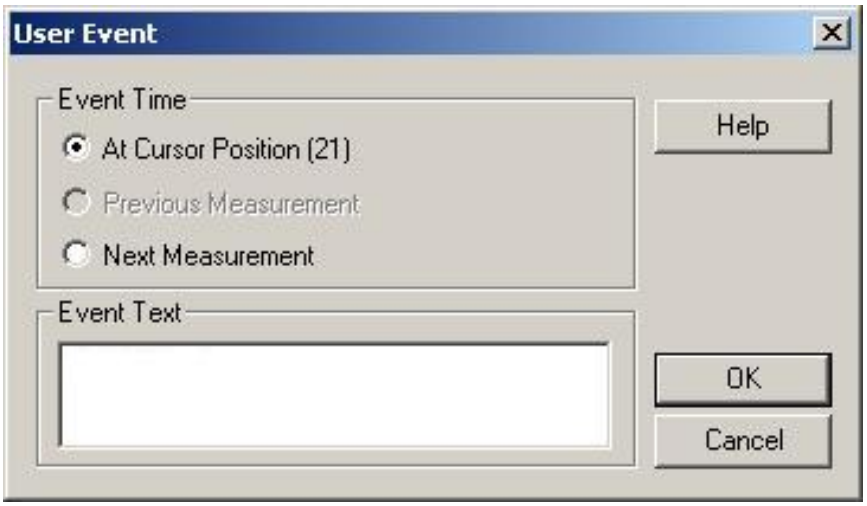
8.5.2 Deleting a User Event Marker

To delete a User Event marker:

1. Position the cursor in the Numeric Window or the Graphic Window, at the desired position.

2. Pull down the **Edit** menu. Click on **User Event** and a new dialogue box opens.

Fig.8.7 The User Event window.



3. Now delete the text in the Events Text field.

4. Click on **OK**.

8.6 Printing Measurement Results.

When using the presentation program, it is possible to make a print-out of the measured data.

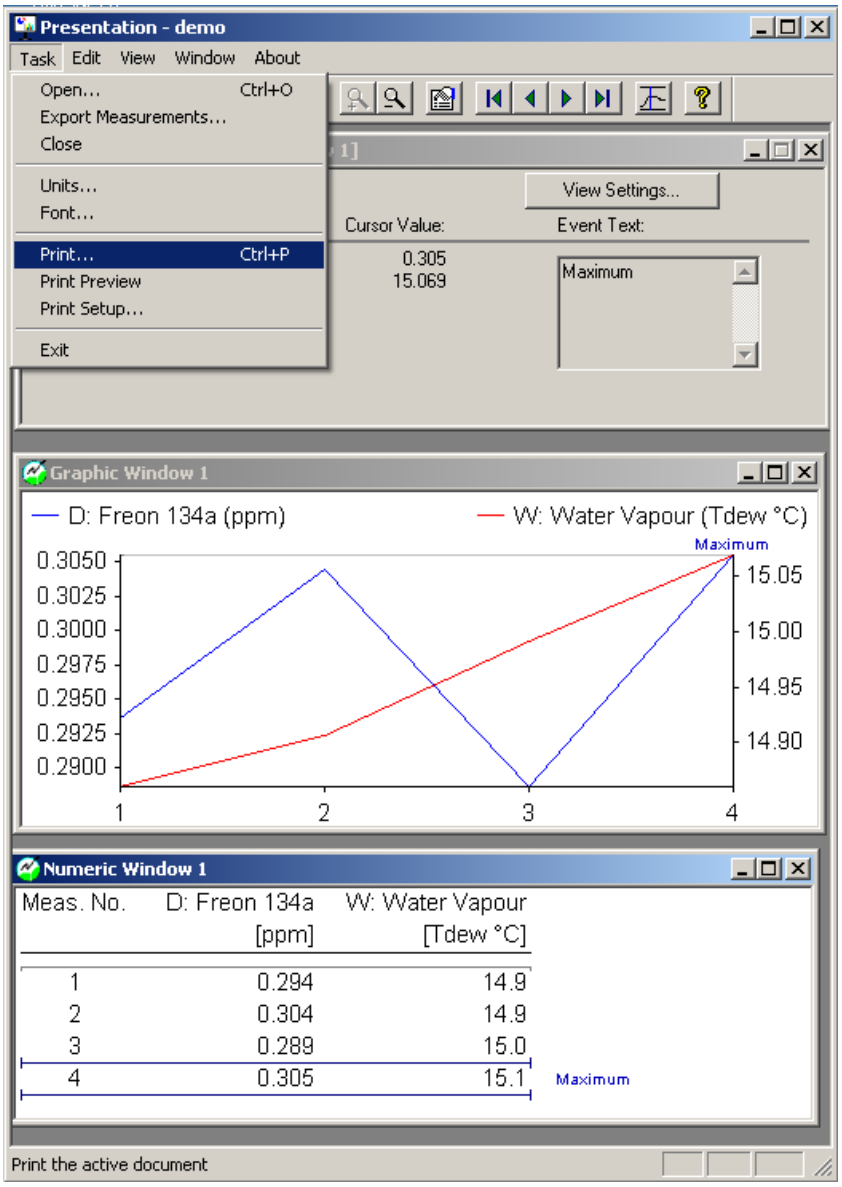
8.6.1 Printing the numeric, graphic or cursor values window

1. Select the specific window by clicking on it while pointing at it with the cursor.

2. Pull down the Task menu

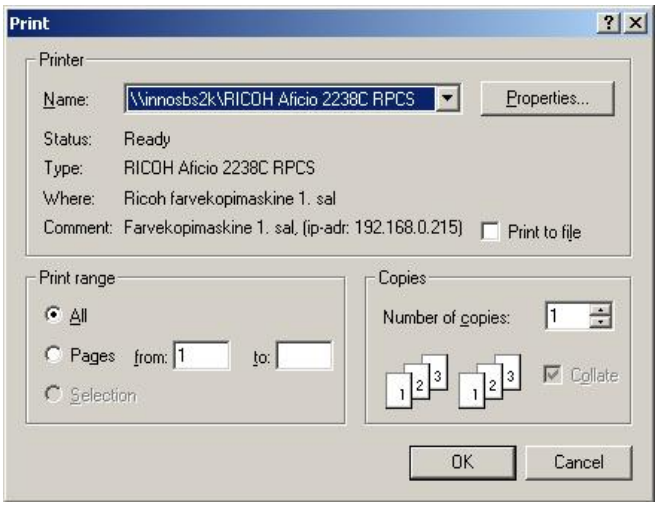
3. Select print (see figure 8.8)

Fig.8.8 The Task dialogue for a print of the numeric window



4. The **Print** window is displayed. Here it is possible to change the print settings. (see figure 8.9).

Fig.8.9 The Print dialogue window for print settings.



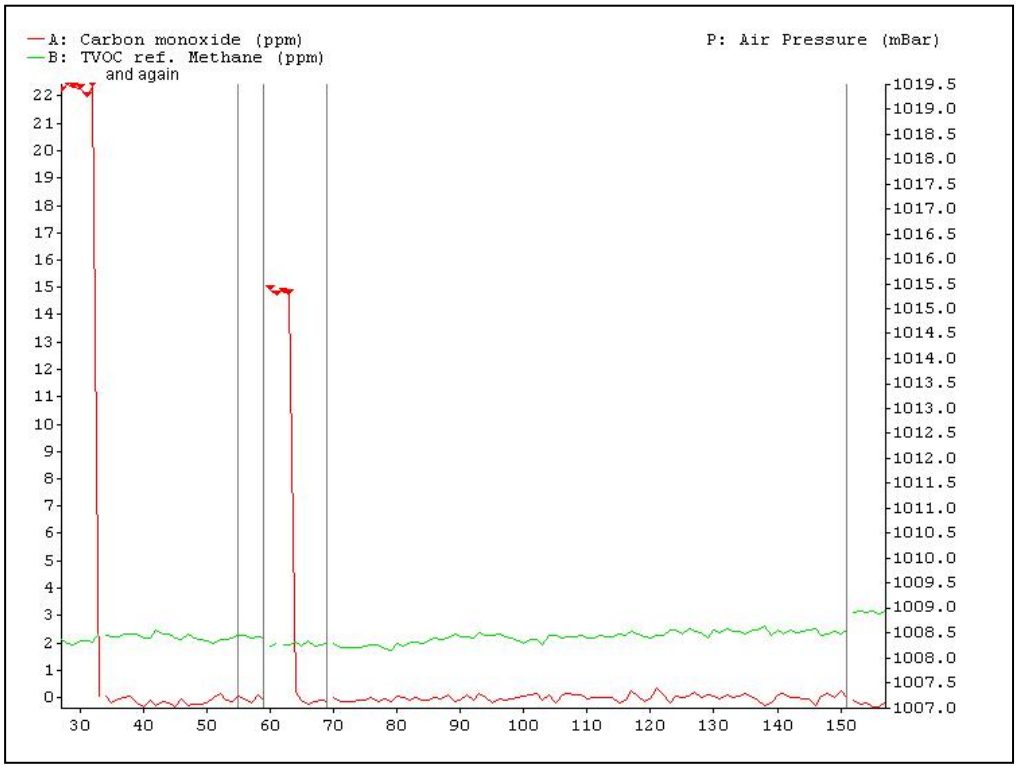
5. Select OK to make the actual print-out of the selected window.

Fig.8.10 Print of the numeric window

1314 i - Serial: 701-002/9312 - 11-06-14 09:14:01 Page: 1

Meas. No.	A: Carbon monoxide [ppm]	B: TVOC ref. Methane [ppm]	W: Water Vapour [Tdew °C]	P: Air Pressure [mBar]
148	0.121	2.314	6.2	1019
149	-0.010	2.412	6.2	1019
150	0.242	2.323	6.2	1019
151	-0.023	2.457	6.2	1019
152	-0.086	3.128	13.8	1007
153	-0.231	3.149	13.8	1007
154	-0.198	3.105	13.8	1007
155	-0.320	3.183	13.8	1007
156	-0.329	3.080	13.8	1007
157	-0.156	3.151	13.8	1007

Fig.8.11 Print of the graphic window.



And the statistical data for either the graphic or the numeric window can be printed out using two cursors (see section 8.4.2)

Fig.8.12 Print of the cursor value window when using two cursors.

Left Cursor :153 Right Cursor:157 No. of Samples: 4

	Minimum:	Average :	Maximum :	Std. Dev.	Slope :
Carbon monoxide (ppm)	-0.329	-0.247	-0.156	0.076	0.002
TVOC ref. Methane (ppm)	3.080	3.134	3.183	0.041	-0.002
Water Vapour (Tdew °C)	13.804	13.826	13.844	0.015	0.001
Air Pressure (mBar)	1.007e+03	1.007e+03	1.007e+03	0.055	0.030

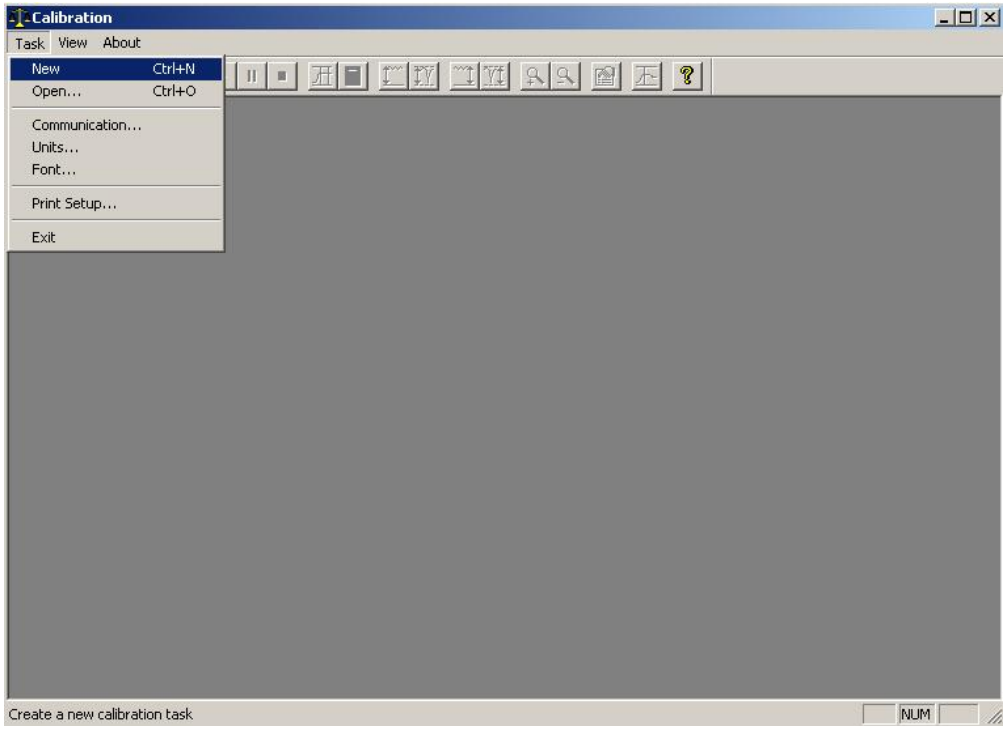
8.6.2 Printing the current calibration data from the monitor.

Whether the 1314i is to be used online or as a stand-alone instrument, the Gas Monitoring Software 7304 can be used to check the Monitors existing calibration. All the calibration factors can be printed out directly from the Gas Monitoring Software 7304 using the **Print Current Calibration** option.

With the PC connected to the monitor and the Calibration program running:

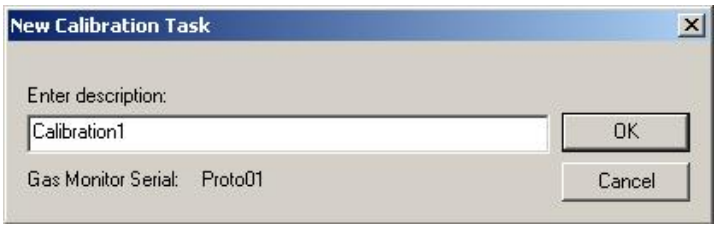
1. Pull down the **Task** menu bar. Click on new and the New Calibration Task dialogue appears (see figure 8.13).

Fig.8.13 The Calibration Task menu bar.



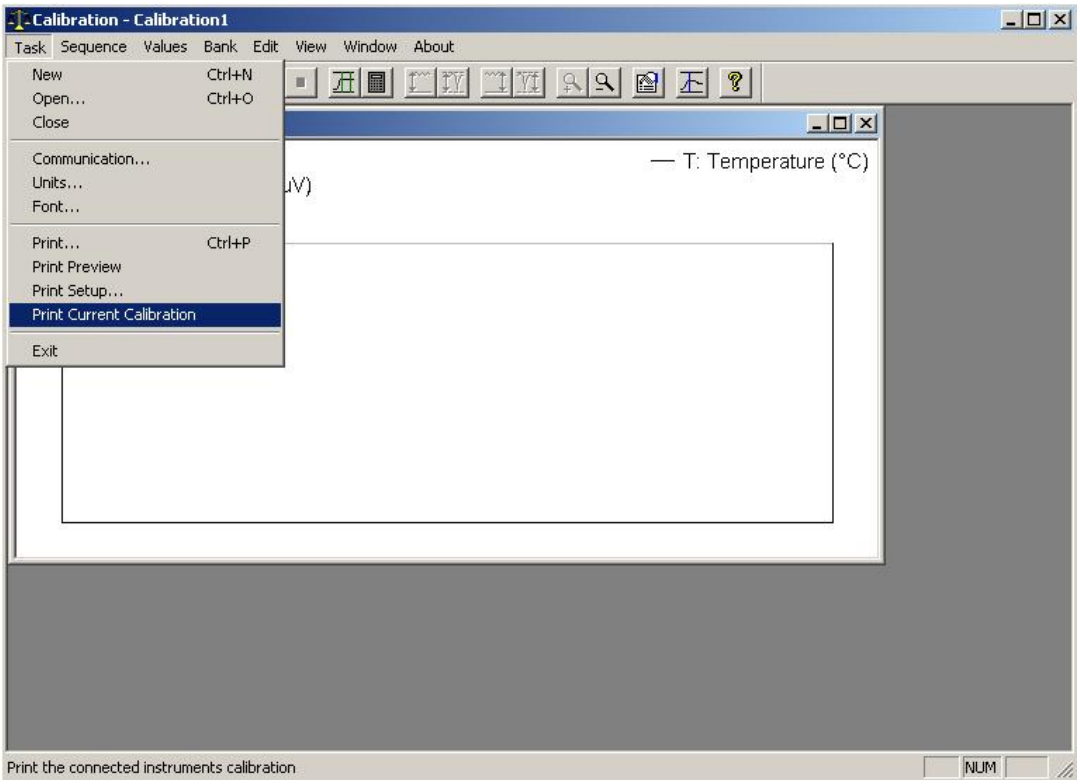
2. Type in the desired calibration task name and click on OK. An extended menu bar and a graphic window appears (see figure 8.14.

Fig.8.14 The New Calibration menu bar.



3. Pull down the Task menu and select **Print Current Calibration.**

Fig.8.15 The Task dialogue window for printing Current Calibration.



4. Now a time-glass appears on the PC-screen, while the calibration data is fetched from the Monitor.
Note this is a time consuming operation.

5. After having fetched the calibration data from the monitor a Print window is displayed.

6. Select OK to make a print-out of the actual calibration data stored in the Monitor.

8.7 Display the Homepage of the gas monitor

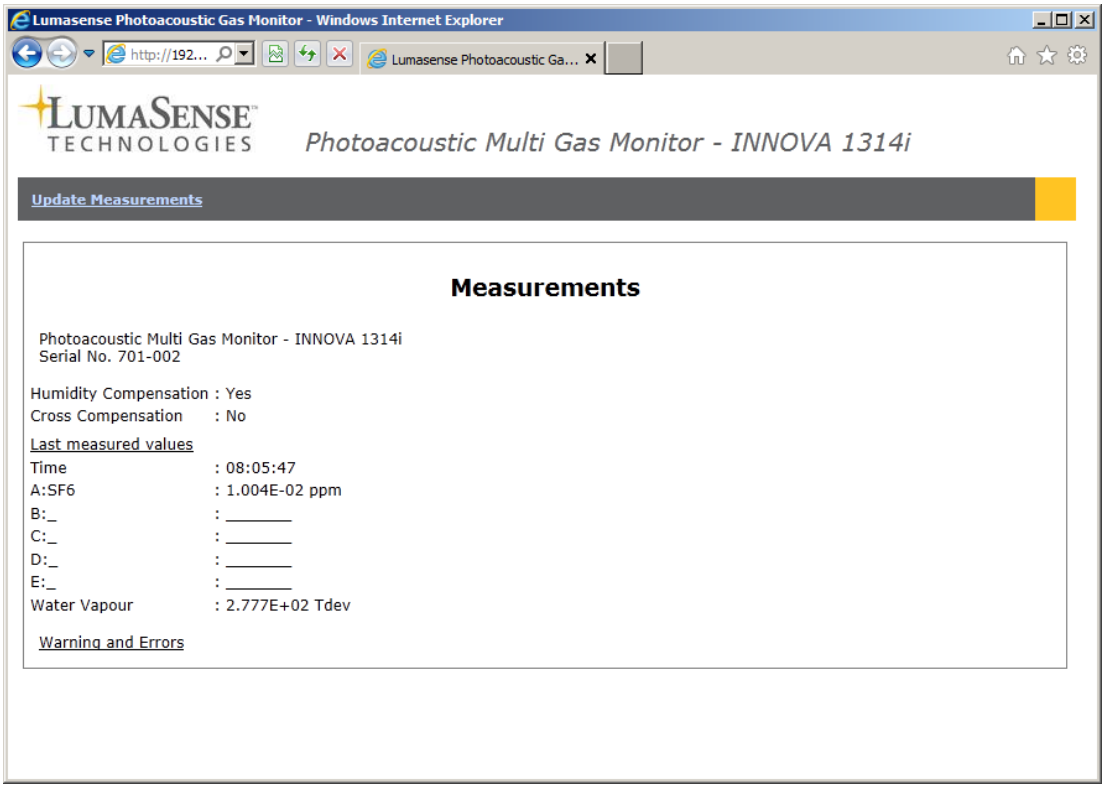
The homepage of the 1314i gas monitor can be displayed if the gas monitor is connected to a Ethernet (TCP/IP) network.

In section 2.6 it is explained how to set-up the TCP/IP parameters in the 1314i gas monitor.

Any web browser can be used to display the homepage of the gas monitor. The IP address obtained from the TCP/IP set-up of the 1314i gas monitor can be entered in the address field of the web browser in order to display the homepage.

The last measured gas values is displayed together with information about the gas monitor, like the device serial number, if water- and cross-compensation is performed.
Error and warning messages (see Chapter 17 for further details) will also be displayed on the homepage.
The gray **"Update Measurements" link** can be used to update the homepage with the last measurement results.

Fig.8.16 The 1314i gas monitor homepage



Chapter 9

Viewing Measurement Data – Using the Monitor

October 2012

9.1 Displayed Monitoring Task Data

When the Monitor is switched on, but not being operated in any **mode**, the screen display text identifies the data stored in its *Display Memory*, by displaying the day and time of the first stored measurement cycle of the monitoring task, as well as the day and time of the last measurement cycle of the monitoring task. For example:

DATA IN DISPLAY MEMORY RECORDED FROM
2011-01-16 09:50 TO 2011-01-16 10:04

If the Monitor has just been **fully reset** then the display will just show the current time and report that the monitor is ready for use.

The Set-up parameters describing a monitoring task and the measurement data collected during the task are stored as a list in the *Display Memory*. You can scroll through the set-up parameters as well as the data collected during the task by using the direction push-buttons, ▼ to scroll "vertically" downwards, and ▲ to scroll "vertically" upwards through the list. Fig.9.1 illustrates how the data is organised:

Identification of Measurements:
This screen provides the date and time of the first and last measurement results, which are stored in *Display Memory*.

Identification of Each Monitored Gas:
This display identifies the gases monitored during the task. By using the ▶ push-button, one can find the names of **all** the gases, which were monitored during the displayed task.

Statistical Analysis of Measurement Results for Each Gas:
Using the individual measured gas concentration stored in *Display Memory*, when Store Measurement History is selected, a statistical analysis is performed which provides a summary of the stored measurement results. The MAX (maximum), MIN (minimum) gas concentrations are displayed, and the μ (Mean or Linear Average) and σ (Standard Deviation) values are calculated and displayed. A description of these statistical terms can be found in section 9.2.1. During the performance of a monitoring task the statistical analysis is updated constantly.

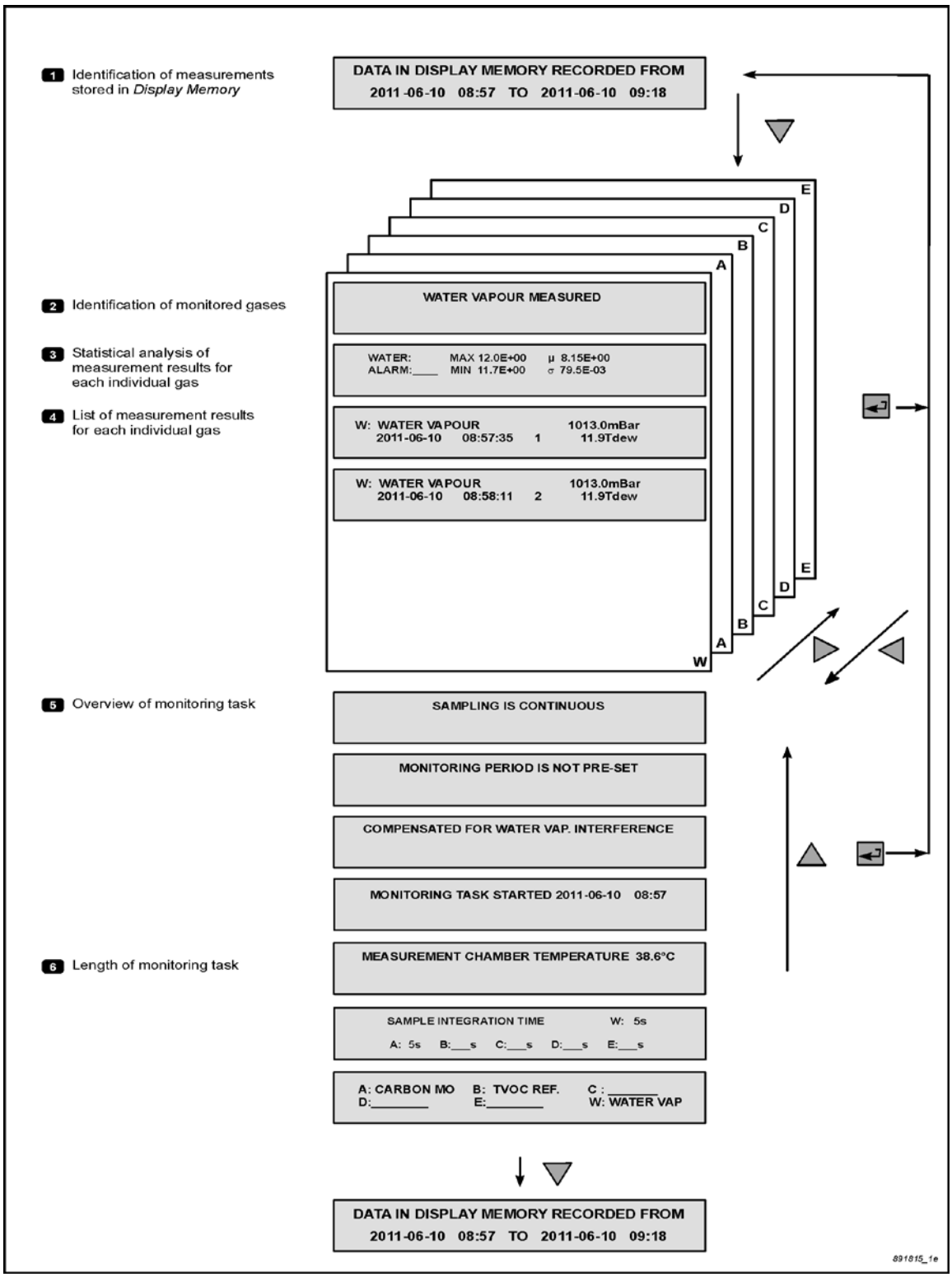
List of Individual Measurement Results:
Each of these displays provide the date and time each measurement cycle was performed and the concentration of the gas whose name appears on the screen. In some cases an asterisk (*) will be shown

alongside the gas/vapour concentration. When such an asterisk is shown, press the **INFO** button. Text will appear on the screen to indicate why this particular measurement has been marked.
The number which is shown on the display – between time and concentration – is only "filled-in" after completion of a monitoring task. The number indicates the order in which the measurements were made. The "oldest" **stored** measurement is always given the number 1 and the following measurements are numbered sequentially.

Overview of the Monitoring Task:
These displays provide an overview of the monitoring task set-up parameters.

Start of the Monitoring Task:
The *Display Memory* has a finite size and therefore, if a monitoring task runs for a long period of time, it will fill up all available memory space, and data collected after the memory has been filled-up will start to overwrite the data collected during the start of the monitoring task. Some measurement results will therefore be lost from the memory. In such a situation the date and time appearing after **MONITORING TASK STARTED…..** will not be the same as the first date and time displayed on the screen labelled **1** in Fig.9.1.

Fig.9.1 Organisation of monitoring-task data displayed on the monitor's screen.


1 Identification of measurements stored in Display Memory
DATA IN DISPLAY MEMORY RECORDED FROM
2011-06-10 08:57 TO 2011-06-10 09:18
2 Identification of monitored gases
WATER VAPOUR MEASURED
3 Statistical analysis of measurement results for each individual gas
WATER: MAX 12.0E+00 μ 8.15E+00
ALARM:____ MIN 11.7E+00 σ 79.5E-03
4 List of measurement results for each individual gas
W: WATER VAPOUR 1013.0mBar
2011-06-10 08:57:35 1 11.9Tdew
W: WATER VAPOUR 1013.0mBar
2011-06-10 08:58:11 2 11.9Tdew
A
B
C
D
E
W
5 Overview of monitoring task
SAMPLING IS CONTINUOUS
MONITORING PERIOD IS NOT PRE-SET
COMPENSATED FOR WATER VAP. INTERFERENCE
MONITORING TASK STARTED 2011-06-10 08:57
6 Length of monitoring task
MEASUREMENT CHAMBER TEMPERATURE 38.6°C
SAMPLE INTEGRATION TIME W: 5s
A: 5s B:___s C:___s D:___s E:___s
A: CARBON MO B: TVOC REF. C : _____
D:_____ E:_____ W: WATER VAP
DATA IN DISPLAY MEMORY RECORDED FROM
2011-06-10 08:57 TO 2011-06-10 09:18
891815_1e

▶ &◀ Using these push-buttons users can scroll “horizontally” through any vertical level of data. For example, if the statistical analysis of the measurement results for water-vapour are displayed on the screen, then by using ▶ you can read the statistical analysis of the measurement results for gas A, B, C etc. and then go back to the original display (see Fig.9.1).

▼ This push-button allows the user to scroll “vertically” downwards through the list of measurement results (see Fig.9.1).

▲ This push-button allows the user to scroll “vertically” upwards through the list of measurement results. The measurement list is a closed loop.

The push-buttons ▲ and ▼ have a repetitive function, which means that if they are pressed continuously they will allow the user to scroll very quickly through a list.

9.1.1 Processing Measurement Data

Gas measurement data stored in *Display Memory* can be processed in the following way:

- It can be processed to produce Time-weighted Average (TWA) concentrations of gases over any user-defined period of time.

The Time-weighted average of these measurements over the averaging period of T min is calculated using the following mathematical equation:

$C_{TWA} = \frac{\sum_{n=1}^{n=N}(C_n)}{N}$ = linear average of all the measurements made during the averaging period.

Where: Cn = constant concentration measured at time Tn;
N = the total number of measurements performed during the averaging period T min.

In the situation where the total monitoring period is the same as the averaging period then the averaged value of the **last** performed measurement will be the same as the Mean Value (μ) shown on the display screen (see 3 in Fig.9.1).

9.2 Printed Monitoring Task Data

Fig.9.1 illustrates how data from a monitoring task is displayed on the Monitor's screen. When monitoring task data appearing in *Display Memory* is printed out, the same information appears but it is presented in a different format. An example of a monitoring task data print-out is shown in Fig.9.3 – Chapter 12 describes how this is done.

Fig.9.3 Print-out of monitoring task data

```
- 1314i Measurement Data ------- 701-002/9312 - 2011-06-11 14:30 - Page 1 -

1314i Settings:
-------------------------------------------------------------------------

Compensate for Water Vap. Interference    :          YES
Compensate for Cross Interference         :          YES
Sample Continuously                       :          YES
Pre-set Monitoring Period                 :           NO
Store Measurement History                 :          YES

Measure
Gas A: Carbon monoxide                    :          YES
Gas B: TVOC ref. Methane                  :          YES
Water Vapour                              :          YES

Flushing Mode                             :         AUTO
Sampling Tube Length                      :       0.00 m
Normalization Temperature                 :       20.0  C

Sample Integration Time
Filter A                                  :          1 s
Filter B                                  :          1 s
Filter W                                  :          1 s

General Information:
-------------------------------------------------------------------------
Start Time                                : 2011-06-11 14:27
Stop Time                                 : 2011-06-11 14:30
Results Not Averaged
Number of Event Marks                     :          0
Number of Recorded Samples                :          6

            Alarm 1    Alarm 2        Max        Mean        Min     Std.Dev
-------------------------------------------------------------------------
Gas A:      _______    _______    -86E-03    -220E-03    -329E-03   94.3E-03
Gas B:      _______    _______   3.18E+00   3.13E+00    3.08E+00   36.7E-03
Water:      _______    _______   13.8E+00   13.8E+00    13.8E+00   13.3E-03
```

9.2.1 Statistical Analysis Terms

In the statistical analysis of the measurement results for each gas (see **3** in Fig.9.1) the following statistics appear:

The Mean Value (μ) – this is the linear average of all measurements of a gas taken during the total monitoring period. The calculation of "the mean value" can be expressed mathematically as follows:

The Mean Value = $\mu = \frac{\sum_{n=1}^{n=N}(C_n)}{N}$

Where: N = measurement cycles performed during the monitoring period (T) between the cursors.
c_n = gas concentrations (where n = 1 to N)

The Standard Deviation (σ) – this is the standard deviation of a particular gas's measurements from the mean value (μ) of this gas. Standard deviation can be expressed mathematically as follows:

The Standard Deviation = $\sigma = \sqrt{\frac{\sum_{n=1}^{n=N}(Cn-\mu)^2}{N-1}}$

Where: μ = the mean value
C_n = individual gas concentrations
N = total number of measurements

9.2.2 Symbols used in Displayed Measurement Data

If an asterisk (*) appears on the display alongside any gas concentration, it indicates that something happened during the measurement. You can find out what the asterisk indicates by pressing the **INFO** button. The following display appears for a short period of time:

GAS X: COMMON MARK: PEOW GAS MARK: BFA
TIME: hh:mm

The symbols which can appear after the text **COMMON MAR**K and **GAS MARK** are listed below with a short explanation of what they mean:

Common Marks:

"P" (1) The Monitor stopped measuring due to a power failure but has automatically re-started the monitoring task again after regaining power;
(2) The Monitor has been "reset" either because of a detected fault or because **RESET** was pressed.

“O” This symbol indicates that an operational error was detected during this measurement. The accuracy of such a measurement cannot always be guaranteed.

“W” This symbol indicates that a warning was detected during this measurement. The accuracy of such a measurement cannot always be guaranteed.

Gas Marks:

“B” The Monitor was incapable of calculating this gas concentration.

“F” After this measurement the filter carousel was found to be out of alignment. If the carousel was only slightly out of alignment then the accuracy of the measurement has not been affected. The accuracy of such a measurement cannot always be guaranteed.

“A” The gas concentration measured during this measurement cycle was found to exceed the user-defined alarm limit for this gas.

9.2.3 Symbols Used in Print-outs of Measurement Data

Displayed measurements marked with the **COMMON MARKS “O”** and **“W”**, and the **GAS MARKS “A”** and **”F”**, are printed-out with an “X” symbol. However, any displayed measurements marked with the **COMMON MARKS “P”** and the **GAS MARK “B”** are not printed-out with these symbols. These measurements are marked in a different way:

Common Marks:

The symbol **“P”** is replaced by the text **“1314i Restarted”**. This indicates that the Monitor stopped and then started-up again sometime between the previous sample time and the time which appears alongside this message.

Gas Marks:

The symbol **“B”** is replaced by a straight line (_____) which indicates that the Monitor was unable to calculate the concentration of the named gas in this sample.

Other Marks Used:

……This symbol indicates either: (1) that this gas was not measured; or (2) that this gas was not selected to be printed out (see section 12.5).

9.3 Storage Space in the Display Memory

Table 9.1 illustrates the space, which is required to store individual measurement results. If 5 gases and water vapour are being measured, then 37 bytes of space are required to store measurement results from one measurement cycle, whereas only 24 bytes of space are required if 3 gases (for example, gas A, E and water vapour (W)) are measured. If only one gas (for example, gas A) is being measured, then only 15 bytes of space are required to store measurement results from one measurement cycle.

The total space available in *Display Memory* to store data is 64 000 bytes. If only one gas (for example, gas A) and water vapour is measured, then data from up to $\frac{6400}{19} = 3368$ measurement cycles can be stored in *Display Memory,* whereas if 5 gases and water vapour were measured, data from up to only $\frac{64000}{37} = 1730$ measurement cycles can be stored in *Display Memory.*

The time required to perform a measurement cycle is dependent upon the number of gases/water vapour being measured.

If we take the examples given above we can work out approximately how long the data from a monitoring task can be stored in *Display Memory*:

Table 9.1 Space occupied by results from one measurement cycle when a different number of gases is monitored

Data being stored	Bytes
Measurement times Event numbers Common flags CRC sum Flags for gas 1 & gas 2 Atmospheric pressure Results for gas 1	4 2 1 1 1 2 4
Results for gas 2	4
Flags for gases 3 & 4 Results for gas 3	1 4
Results for gas 4	4
Flags for gases 5 & 6 Results for gas 5	1 4
Results for gas 6	4

15 bytes

19 bytes

24 bytes

28 bytes

33 bytes

37 bytes

If a measurement cycle in which gas A and water vapour are measured takes 15s, and if sampling is continuous this means that 3 368 cycles will take 3 368 x 15 = 50 520s = 14 hours. If, however this measurement cycle is only performed every 10 mins then data can be stored for 3 368 x 10 = 33 680 mins = 23 days.

If a measurement cycle where 5 gases and water vapour are measured takes 60 s, and if sampling is continuous this means that 1 730 cycles will take 1 730 x 60 = 103 800 s = 28.8 hours. If, however this measurement cycle is only performed every 10 mins, then data can be stored for 1 730 x 10 = 17 300 mins = 12 days.

For further information regarding measurement cycles see chapter 4.

The maximum time you can set a monitoring period to be is 7 days. If you try to enter a greater number of days, the Monitor will automatically change the period to 7 days. However, if you do not set a pre-defined monitoring period, the Monitor will just store as much data as possible before starting to overwrite the “oldest” stored measurement results.

Chapter 10

Database Administration for PC Use

October 2012

10.1 Introduction

The 7304 Database Administration program enables you to backup, restore and delete the databases you have stored on your hard disc. This chapter also explains how to export data. This is achieved using the Presentation program.

Note: database files **cannot** be copied or moved using Windows Explorer. In order to copy and move files that will continue to work with the Gas Monitoring Software 7304, follow the instructions below.

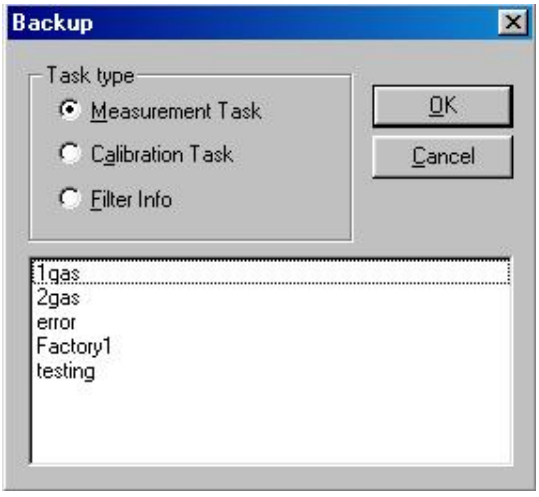
10.2 Backup Databases

This option enables you to make a backup copy of your existing databases. There are three types of files that can be backed up here: Measurement Tasks; Calibration Tasks; and Filter Information.

With the Database Administration program running:

1. Click on **Backup** and the dialogue shown in Fig.10.1 is displayed

Fig.10.1 The Backup dialogue



2. Click on the radio-button to select the type of data to be backed up.

3. Select the correct name from the list displayed and click on **OK**.

4. Now define the destination where the backup should be stored and click on **OK**.

A copy of the selected database is now made. If you want to use this database again, use the Restore option.

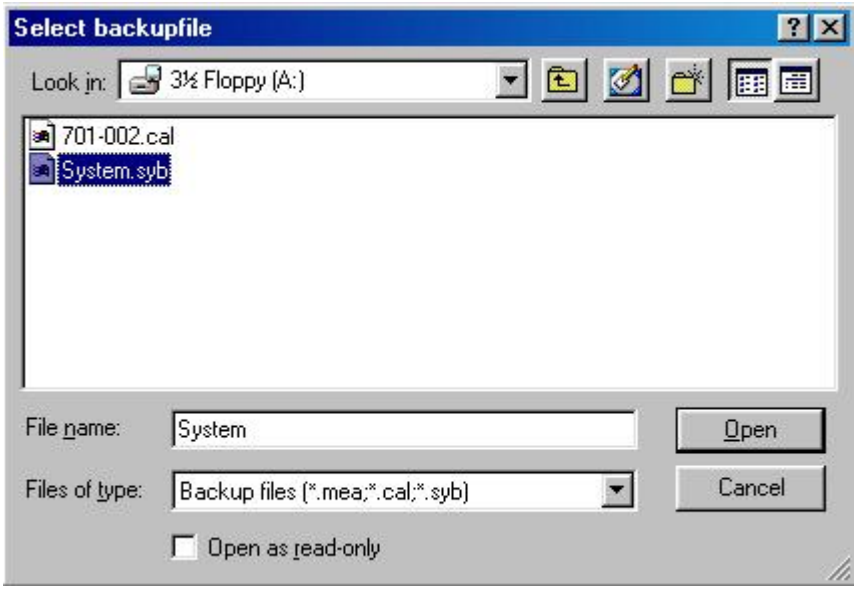
10.3 Restore Databases

This option enables you to restore backup copies of databases, so that they may be used again in the Gas Monitoring Software 7304. All backup files, made using the Backup option, can be restored.
Restored databases can be restored as “read-only” files. This prevents you from adding additional measurement data to the database, or corrupting the existing data. This is of particular use when restoring Calibration databases that must not be changed.

With the Database Administration program running:

1. Click on **Restore** and the dialogue shown in Fig.10.2 is displayed.

Fig.10.2 The Select Backup files dialogue



2. Use the standard Windows browser procedures to select the databases to be restored.

3. If you want to restore the database(s) as a read-only file(s), click in the Open as read-only check box.

4. Click on **Open**. The selected files are restored to the Gas Monitoring Software 7304 working directory.

Click on **Cancel** to exit the Restore dialogue when all the desired databases have been restored.

10.4 Delete Databases

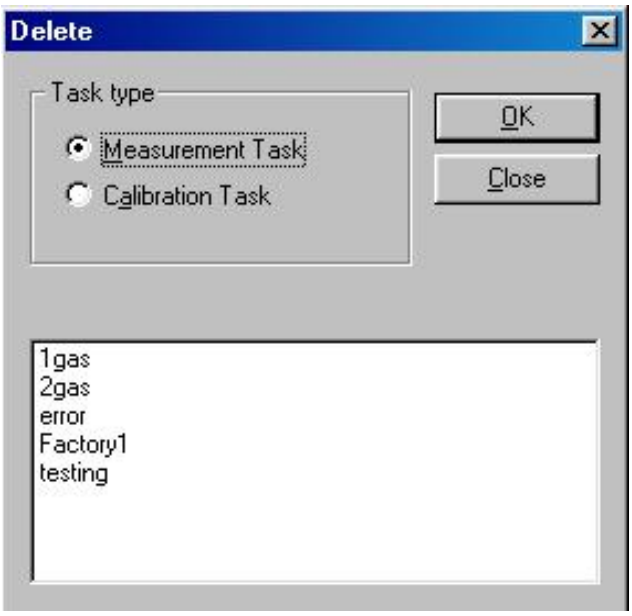
This option enables you to delete measurement and calibration databases from the Software working directory without disturbing the filter information.

Note: using Explorer to delete files may result in information in remaining databases being damaged or deleted by mistake.

With the Database Administration program running:

1. Click on **Delete** and the dialogue shown in Fig.10.3 is displayed:

Fig.10.3 The Delete dialogue



2. Click on the radio-button to select the type of data to be deleted.

3. Select the correct name from the list displayed and click on **OK**. A warning appears, to confirm that you do want to delete the selected database.

4. Confirm the deletion by clicking on **Yes**.

Click on Close to exit the Delete dialogue.

10.5 Export Databases

This option enables you to export existing databases as comma-delimited ASCII files. The export function works from within the Presentation program. The database to be exported must be open.

Note: only the data displayed, either in a numeric or graphic window is exported.

With the desired data displayed, as described in section 8.2 and section 8.3:

1. Pull down the **Task** menu and click on **Export**.

2. Use the standard Windows browser, which appears on screen, to define the destination for the exported data.

3. Type in the desired file name. All files have a .TXT extension.

4. Click on **Save**.

Chapter 11

Storage of Data in the Monitor's Memory

October 2012

In order to fully understand the functioning of the Monitor it is necessary to know something about the different types of memory the Monitor uses, the kind of data stored in each type of memory, and how this data is affected by the various operations performed by the Monitor.

Offline users may find the information in this chapter of interest as their measurement data is stored in the Monitor's memory before being uploaded to the PC. However, any mention of selecting or setting up **active** filters or filter banks in this chapter is not applicable as these are set-up or selected in the Offline Sequence Settings dialogue.

11.1 Types of Memory in the Monitor

The Monitor has three types of memory:

1. A **R**ead **O**nly **M**emory (**ROM**);
2. An **E**lectrically **E**rasable **P**rogrammable **R**ead **O**nly **M**emory (**EEPROM**), which we have named the ***Source Memory***;
3. A **R**andom **A**ccess **M**emory (**RAM**) which we have named the ***Working Memory***.

11.1.1 Read Only Memory (ROM)

Data stored in this memory cannot be changed by the user. The **Optical Filter Factors**, which describe each of the optical filters, which are available for installation in the Monitor, are stored in this memory. These factors are listed in a print-out of the "Calibration Data Block" (see section 12.7).

When optical filters are installed in the carousel wheel, the Monitor must be informed about:

- **Which** filters have been installed in its carousel (UA numbers of the filters);
  and
- **Where** they have been installed (position "A" – "E" of the carousel – see section 14.3.3).

This information allows the Monitor to read the correct optical filter factors from its **ROM** memory when the filter is installed. As these factors are used in the calculation of calibration factors, it is **vitally important** that this information is correctly entered **before** calibration is performed.

11.1.2 Source Memory (EEPROM)

The data stored in ***Source Memory*** is not lost if A.C. mains power is removed from the Monitor. There are three blocks of data in the ***Source Memory*** (see Fig.11.1):

Block 1 – contains calibration factors and 3 optical-filter parameters
Block 2 – contains 3 of the 6 set-up parameters found under the **Filters** branch of the set-up "tree"
Block 3 – contains all other parameters in the Set-Up Tree

Block 1 – Calibration Factors and 3 Optical-filter Parameters:

There are six different "data files" in this block. Each data file is denoted by a letter, which indicates the position a particular optical filter occupies in the Monitor's carousel. Each file "A" to "E" is divided into **five** sections called **Filter Banks**, which are numbered from 1 to 5. The water-vapour filter is only capable of measuring water-vapour and therefore its data file ("W") is not divided into different filter banks.

Each **Filter Bank** contains the following data:

1. The name of the gas used during span calibration of the filter.

2. The molecular weight of the gas used during span calibration.

3. The alarm limits for the gas. (High Alarm Limit 1, High Alarm Limit 2).

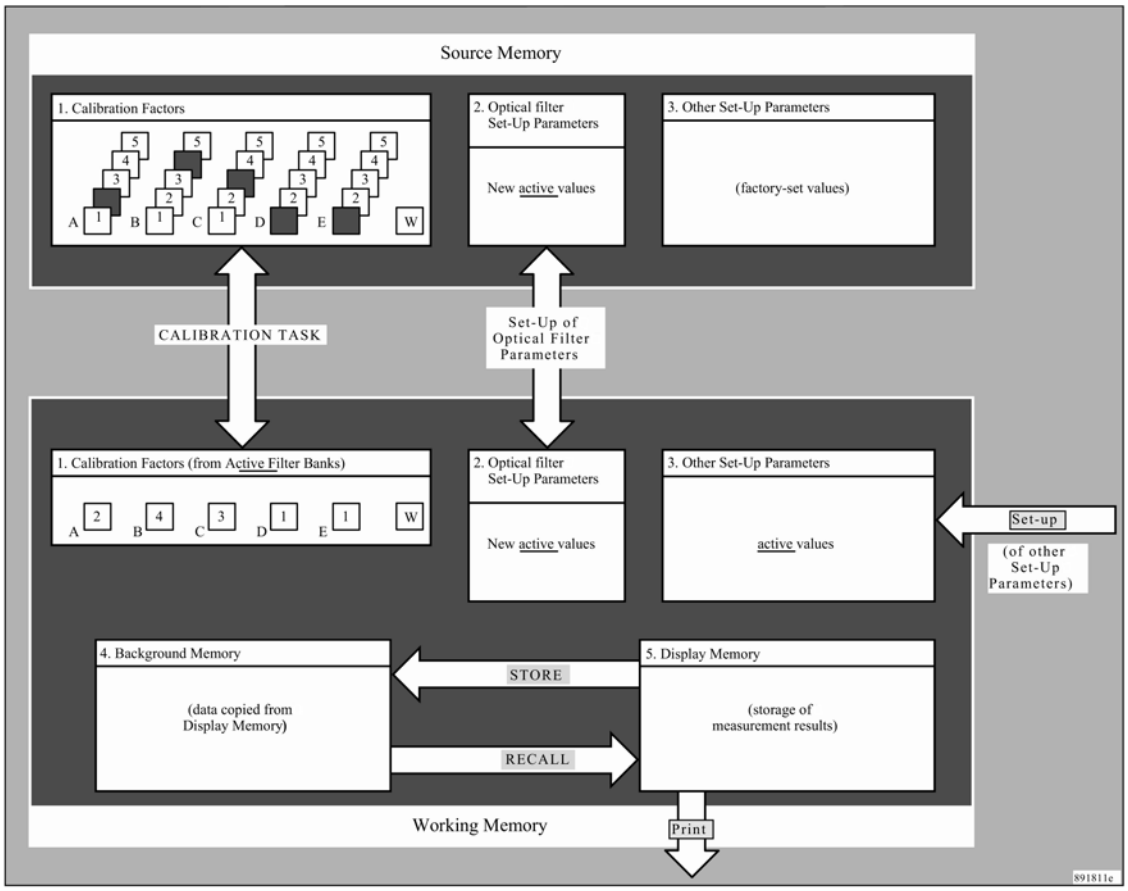
4. A **Concentration offset factor:** obtained during zero-point calibration of the filter.

5. A **Humidity gain factor:** obtained during an humidity-interference calibration of the filter.

6. A **Conversion factor:** obtained during the span calibration of the filter with the gas named in point 1 above.

7. **Cross-interference calibration factors:** obtained during cross-interference calibration.

Fig.11.1 Schematic diagram showing the structure of the Monitor's memory



Before calibrating a particular filter, one of the filter's banks is made **active** (by operating the Monitor in **Set-Up mode** and "entering" the chosen filter-bank number for the filter being calibrated). The filter bank No. which is made **active** before the filter is calibrated, is the filter bank where the Monitor will store calibration factors calculated during calibration. This means that the user is able to calibrate any particular optical filter to measure up to **five** different gases.

If a particular filter is to measure more than one gas, it is therefore necessary to **span** calibrate it with each of the gases it is to measure. For example, if you refer to the **"Gas Detection Limits"** wall chart you will see that the filter UA 0976 can be used to measure the following three gases:

1. Sulphur hexafluoride
2. Acetic acid
3. Vinyl chloride

Suppose that filter UA 0976 is installed in position "A" of the filter carousel to measure each of the above gases. Before this filter is calibrated, the Monitor has to be told where to store the calibration

factors which are calculated during the calibration procedure. This is done by selecting a **FILTER BANK NO.** – in the active set-up for Filter A each time the filter is calibrated. For example, Filter Bank No.”1” for storage of the calibration factors for sulphur hexafluoride, Filter Bank No.”2” for acetic acid and Filter Bank No.”3” for vinyl chloride.

After calibration of the filter UA 0976 the Monitor is able to accurately monitor any of the three gases mentioned – but only **one** of these gases during any particular monitoring task. By selecting the correct **FILTER BANK NO.** in the set-up of the Monitor before a monitoring task is started, the user determines which calibration factors will be used during the task and therefore the kind of gas monitored by filter A. For example, when Filter Bank No.”3” is entered in the **active** set-up for filter UA 0976 in position ”A”, the Monitor reads the calibration factors from file “A3” into its ***Working Memory*** so that the concentration of vinyl chloride can be calculated during the monitoring task.

Block 2 – Optical Filter Set-up Parameters:

This block contains 3 of the 6 parameters, which describe the optical filter installed in each position of the filter carousel:

UA number of the filter;
Filter bank number;
S.I.T. information;

If any of the above-listed parameters are changed in the **active** set-up they are also automatically changed in the ***Source Memory***.

Block 3 – Other Set-Up Parameters:

This block of data contains all set-up parameters except the optical filter parameters. Before leaving the factory the parameters in this block are given factory-set values. These are the values obtained for a parameter when the **Default** button is pressed.

11.1.3 Working Memory (RAM)

The ***Working Memory*** is a “volatile” memory, that is, data will be lost from it if electric power is removed from the Monitor. When the Monitor is not connected to a mains power supply a lithium battery in the Monitor provides a back-up power supply to protect the data in this memory. When this battery is no longer providing enough power a warning **BACK-UP BATTERY TOO LOW** will appear on the Monitor’s display to indicate that the battery needs to be replaced by a new one.

There are four different blocks of data in the ***Working Memory*** (see Fig. 11.1):

Block 1 – contains only calibration factors and 3 optical-filter parameters from each of the active "Filter Banks".

Block 2 – contains 2 of the 5 optical filter parameters with values which are the same as those found in Block 2 of the ***Source Memory***.

Block 3 – contains all other set-up parameters (i.e. excluding the optical filter parameters) with **active** set-up values.

Block 4 – this block contains measurement data, which was copied into it from the *Display Memory*. This block is called *Background Memory* because the data stored in it cannot be **accidentally** deleted.

Block 5 – contains data collected during the performance of a monitoring task. This data block is named the *Display Memory* because this data is displayed on the Monitor's screen while a monitoring task is being performed.

Block 1 – Calibration Factors and 3 Optical-filter Parameters from Each Active Filter Bank:

If, for example, 5 optical filters are installed in the Monitor and their UA numbers have been entered in the **active** set-up and Filter Bank No. 2 has been selected for filter "A"; no. 4 for filter "B"; no. 3 for filter "C"; no. 1 for filter "D" and no. 1 for filter "E", then only calibration factors from filter banks A2, B4, C3, D1, E1 and W will be stored in this block of data (see Fig. 11.1). The name, molecular weight and alarm limits of each gas will also be stored in this block.

Block 2 – Optical Filter Set-up Parameters:

Whenever either an optical filter's UA number or its **active** Filter Bank Number is changed, the same values are automatically read into Block 2 of the ***Source Memory***.

Block 3 – Other Set-up Parameters:

The **active** set-up values are those values, which are underlined by a cursor on the display screen of the Monitor when it is operated in **Set-Up** mode.

Block 4 – Measurement Data:

Whenever the Monitor performs any operation, which results in data occupying the *Display Memory*, the data already stored there will be deleted. To reduce the risk of accidental losing data from *Display*

Memory, a **warning "WARNING: DISPLAY MEMORY WILL BE DELETED"** is displayed whenever a user attempts to perform an operation with the Monitor, which will result in the deletion of data from *Display Memory*.

Data in *Display Memory* can be copied into the Monitor's *Background Memory* (see Block 5 below) to protect it against accidental deletion. Alternatively, the data in *Display Memory* can be printed out by connecting a printer to the Monitor and transmitting data via either the IEEE 488 or the RS 232 interface port of the Monitor (see Chapter 12).

The storage space in *Display Memory* is finite. Once this memory has been filled by data from a monitoring task any additional data collected will start to overwrite some of the data already stored there (see section 7.2.2 for details)

Block 5 – Stored Measurement Data:

By selecting to **STORE** data when the Monitor is operating in M**emory** mode the user can copy data from *Display Memory* into *Background Memory* to "protect" data against accidental deletion from the *Display Memory* (see section 11.3.1 for further details).

The storage space in *Background Memory* is finite and is exactly the same size as the storage space available in *Display Memory* (see section 9.3 for further details).

Data which has been stored in *Background Memory* can be recalled to the *Display Memory*. This is done by operating the Monitor in **Memory** mode and selecting to **RECALL** data (see section 11.3.2). When data is "recalled" to *Display Memory* it is not **transferred** from *Background Memory* to *Display Memory*, it is only **copied** into *Display Memory* so there is no risk of losing it. In *Display Memory* the user can scroll through the data.

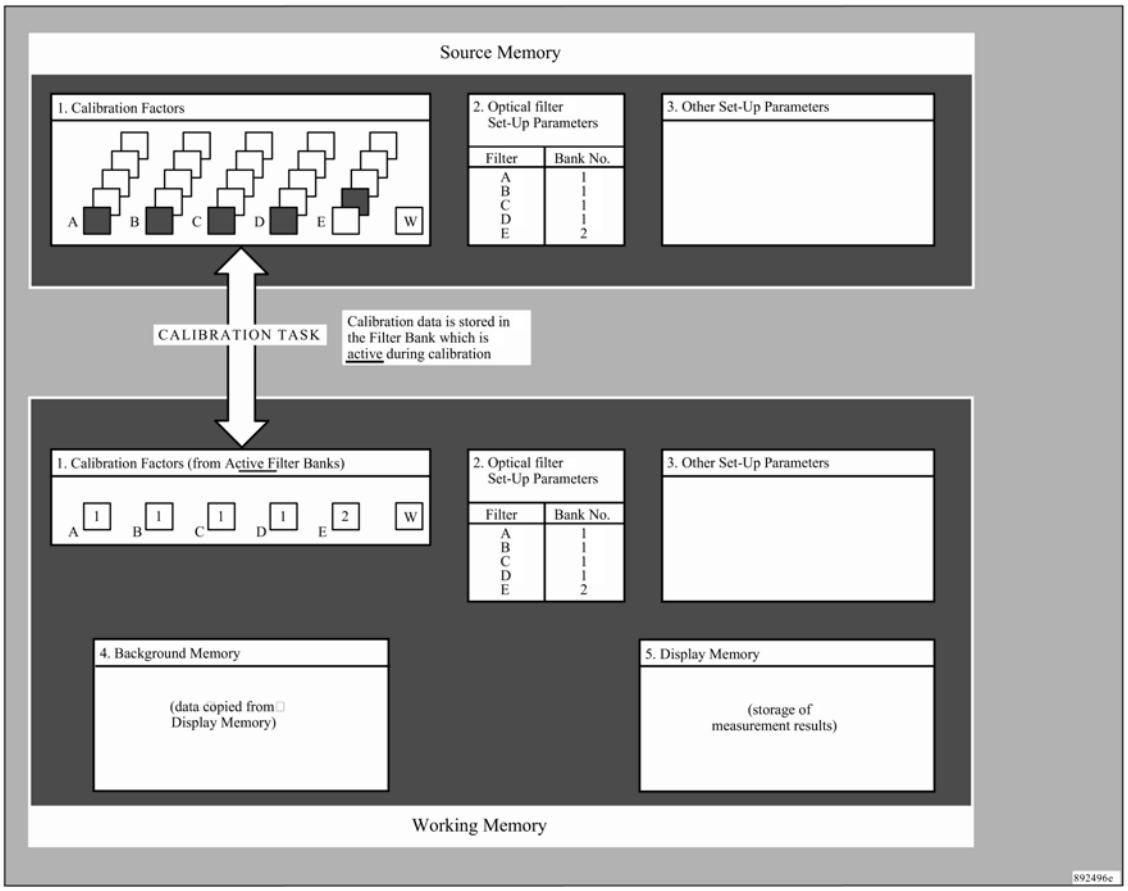
Data stored in *Background Memory* can be deleted by operating the Monitor in **Memory** mode and selecting to **DELETE** data (see section 11.3.3).

11.1.4 Effect of a Calibration Task on the Monitor's Memory

Before calibration of the optical filters in the Monitor the UA numbers of each of the installed filters is "entered" into the **active** set-up of the Monitor. This enables the Monitor to find a set of numerical parameters, which describe each numbered optical filter (this information is found in the **R**ead **O**nly **M**emory of the Monitor). These numerical parameters are called Optical Filter Factors.

During a **CALIBRATION TASK** the Monitor uses these Optical Filter Factors to calculate the calibration factors for each installed optical filter. As explained in section 11.1.2, by "entering" a Filter Bank No. in the **active** set-up before calibration of any particular filter with any particular gas, each filter can be calibrated to measure up to five different gases and the filter bank number tells the Monitor exactly where (in the ***Source Memory***) to store the calibration factors calculated during the calibration task.

Fig.11.2 The state of the Source Memory after completion of a ***CALIBRATION TASK***



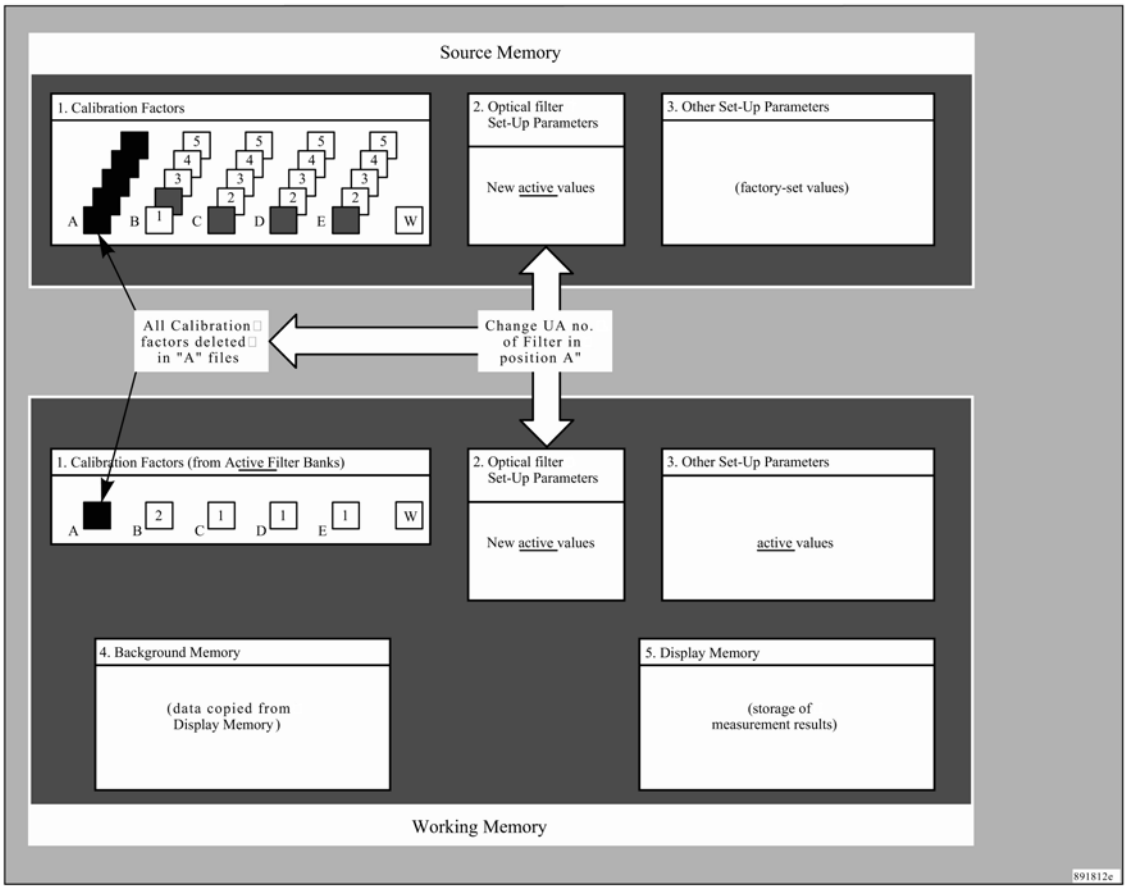
After completion of a calibration task the calibration factors, which are found in the ***Working Memory,*** are entirely dependent upon the Filter Bank No., which is **active** for each optical filter. If Filter Bank No. 1 is **active** for filters in positions "A" to "D" and Filter Bank No. 2 is **active** for the filter in position "E" then calibration factors from files A 1, B 1, C 1, D 1, E 2 and W will be found in ***Working Memory*** (see Fig 11.2).

11.1.5 Effect of Changing the UA number in the "Active" Set-up

WARNING!: *Changing the UA number of a filter in the Monitor's active set-up will destroy all calibration data for the filter.*

As explained in section 11.1.1, the UA No. determines the set of Optical Filter Factors used during the calculation of calibration factors and therefore, if the UA number of any filter is changed in the **active** set-up of the Monitor, all calibration data related to the optical filter whose number has been removed from the set-up is **automatically** deleted from both the ***Source Memory*** and the ***Working Memory*** as it is no longer valid.

*Fig.11.3 Effect of changing a UA number in the **"active" set-up***



For example, if the UA number of the filter installed in position "A" of the filter carousel is changed in the **active** set-up then calibration factors are deleted from the active file "A" in the ***Working Memory*** and from files A 1, A 2, A 3, A 4 and A 5 in the ***Source Memory*** of the monitor (see Fig.11.3). The Monitor will not be able to measure any gas with filter "A" until it has been fully calibrated, see Chapter 14 for details.

11.1.6 Effect of a Full Reset on the Monitor's Memory

A **FULL RESET** of the Monitor changes the data stored in its ***Working Memory*** as follows:

1. All data stored in *Display Memory* and *Background Memory* is deleted.

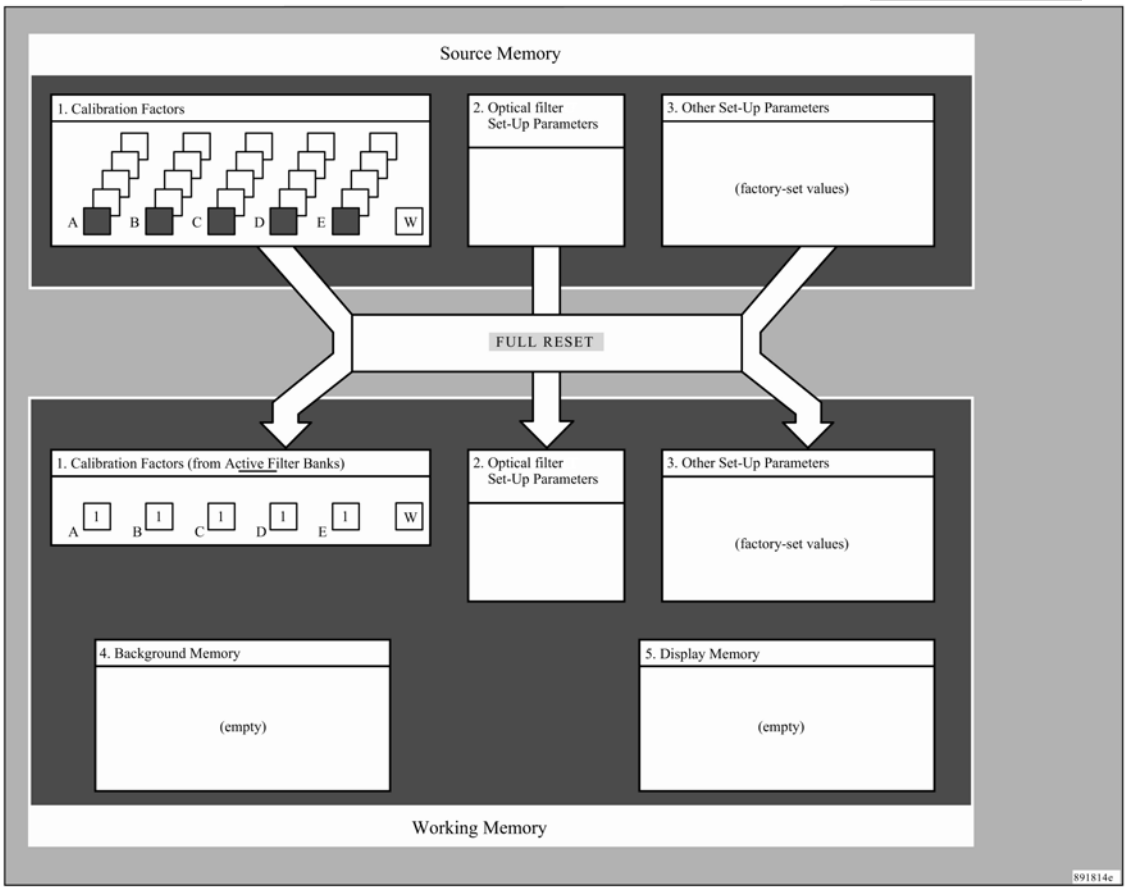
2. Values of the Optical Filter Set-up Parameters in Block 2 of The ***Source Memory*** are copied into Block 2 of the Working Memory.

3. The **active** values of the other set-up parameters in Block 3 of the ***Working Memory*** are replaced by the factory-set values defined in Block 3 of the ***Source Memory***.

4. The **active** values of the Optical Filter Parameters in Block 2 of the ***Working Memory*** are replaced by the values of the optical filter parameters in Block 2 of the ***Source Memory***. Note that under normal circumstances the data in these blocks is the same. However, to ensure that the data in these blocks **is** the same, data is read from ***Source memory*** into the ***Working Memory*** during a **FULL RESET** of the Monitor.

5. Those Filter Bank Nos. which have been made **active** determine the calibration factors which will be found in Block 1 of ***Working Memory*** after a **FULL RESET** of the Monitor. If, for example the **active** Filter Bank No. chosen for all the filters "A" to "E" is no. 1, then only the calibration data in files A 1; B 1; C 1; D 1; E 1; and W will be found in the Monitor's ***Working Memory*** after a **FULL RESET**. This example is illustrated in Fig.11.4.

*Fig.11.4 The state of the Working Memory after a **FULL RESET***



11.2 Storage of Measurement Results

While a monitoring task is being performed measurement data is stored in the Monitor's *Display Memory*. When the monitoring task is complete the data in Display Memory is normally copied into the Monitor's *Background Memory* to prevent it from being overwritten (and therefore lost) by measurement data stored during the next monitoring task. The same amount of data can be stored in both the *Background Memory* and the *Display Memory*.

Structure of the Background Memory:

The data from a maximum of 10 monitoring tasks can be stored in the *Background Memory* provided the total amount of data from the 10 tasks does not exceed the total capacity of the *Background Memory*. Each monitoring task stored in the *Background Memory* is given a "location number" (from no. 1 to no. 10). The size of each location is flexible and is equal to the space required to store all the data collected during a monitoring task.

If data from a single monitoring task totally occupies the *Display Memory*, then this data can be stored in *Background Memory*

provided that no data is already stored there. The data will occupy only one location of *Background Memory* and fill all available storage space. Therefore, it will not be possible to store any data from any new monitoring task in *Background Memory* unless the data already stored there is first deleted (see section 11.3.3).

To illustrate the variable size of each location let us suppose that the following monitoring tasks are performed:

Task No. 1: The data collected in *Display Memory* occupies 20% of the total capacity of the *Display Memory*. The data can be stored *in Background Memory* provided that the data already stored there occupies less than 80% of the total capacity of the *Background Memory*. However, let us suppose that the *Background Memory* is empty and that we **STORE** the data from this monitoring task in location 1 of *Background Memory*. This means that *Background Memory* is now 20% full (see Fig.11.5).

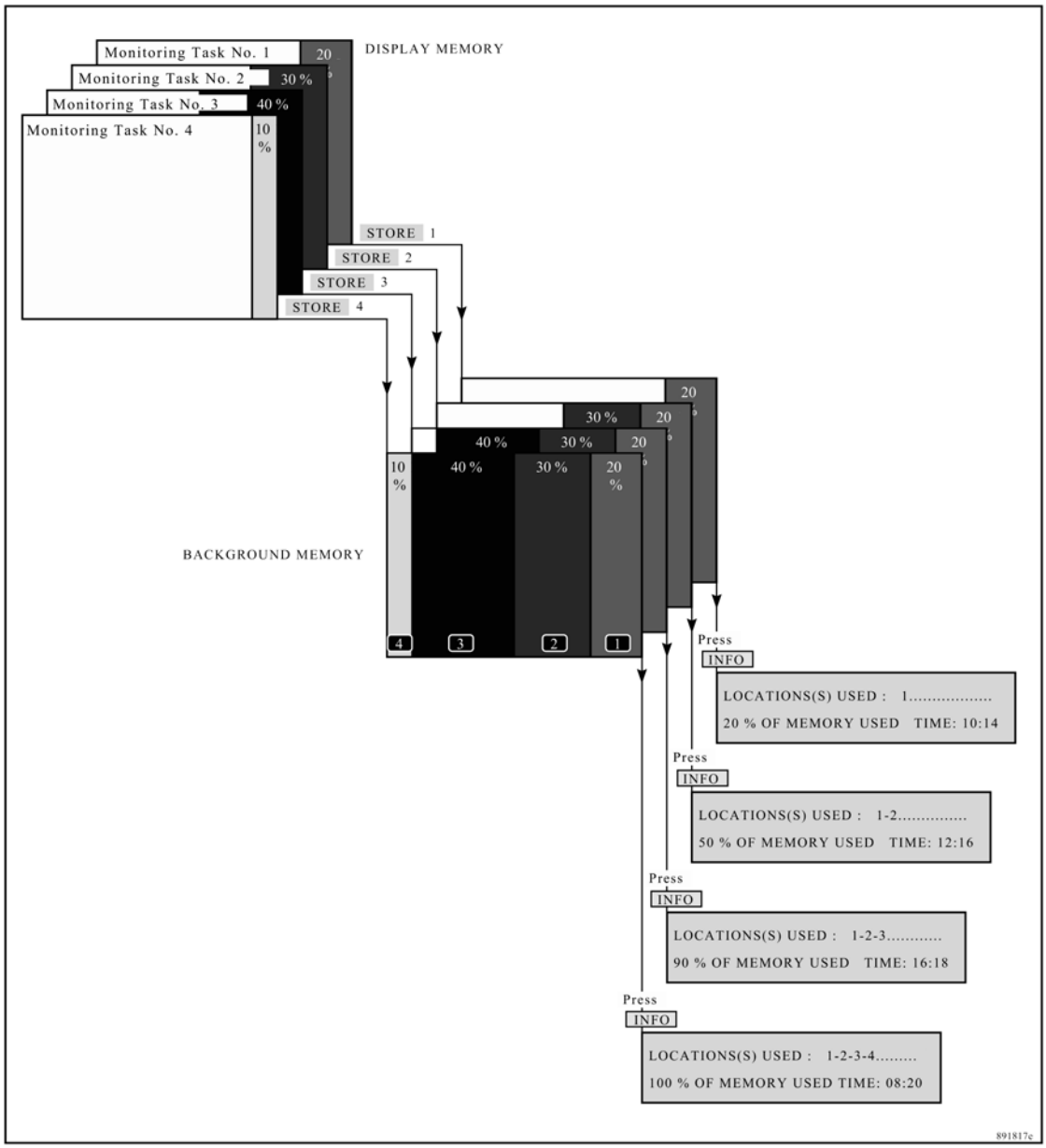
Task No. 2: The collected data occupies 30% of the total capacity of the *Display Memory*. Let us suppose that we **STORE** the data in location 2 of *Background Memory*. This means that *Background Memory* is now 50% full (see Fig.11.5).

Task No. 3: The data occupies 40% of the total capacity of the *Display Memory*. Let us suppose that we **STORE** the data from this task in location 3 of *Background Memory*. *Background Memory* is now 90% full (see Fig.11.5).

Task No. 4: The data occupies 10% of the total capacity of the *Display Memory*. Let us suppose that we **STORE** the data from this task in *the Background Memory* – let us say it is stored in location 4. *Background Memory* is now 100% full (see Fig.11.5).

The *Background Memory* has now been filled-up by the data from the four monitoring tasks described above, even though location nos. 5 – 10 (inclusive) have not been used. The user will not be able to **STORE** any more data in *Background Memory* because there is no space available for it. Data in *Background Memory* can, however, be deleted to make space for the storage of new measurement results (see section 11.3.3).

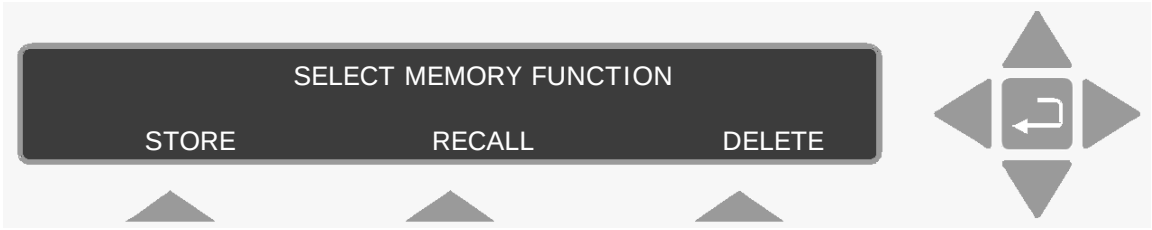
Fig.11.5 Storing data from 4 different consecutive measurement tasks in the Background Memory.



Whenever the Monitor is operating in Memory **mode** the user can, by pressing the **INFO** push-button, find out what percentage of the *Background Memory* is occupied and which location numbers have been used to store data. Fig.11.5 illustrates the status information one can obtain from the Monitor during various stages of the four monitoring tasks described above. Further information about the **INFO** push-button can be found in section 11.3.4.

11.3 Management of Data in Background Memory

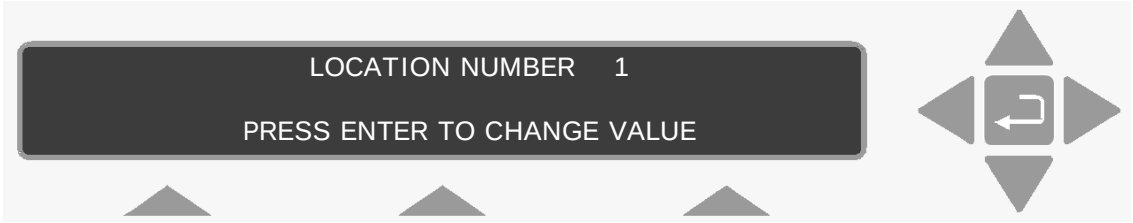
The monitor has to be operated in Memory mode by pressing the **MEMORY** push-button. The following text appears on the screen:



11.3.1 Storing Data in Background Memory

When data is to be copied from *Display Memory* into *Background Memory*:

Press **S1**

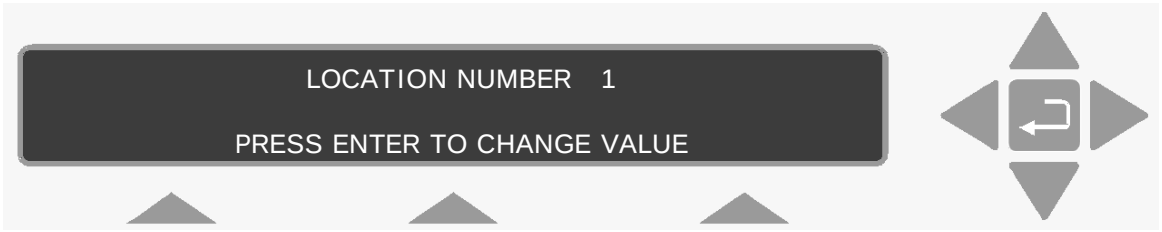


If some data has already been stored in the *Background Memory* and you cannot remember which locations have been occupied (used), press the **INFO** push-button to find out which locations are occupied and what percentage of the *Background Memory* has been used (see section 11.3.4). Use the direction keys to select the desired location number. When the chosen location number is on the screen, press **S2** to accept the position.
Press **Memory** to exit.

11.3.2 Recalling Data from Background Memory

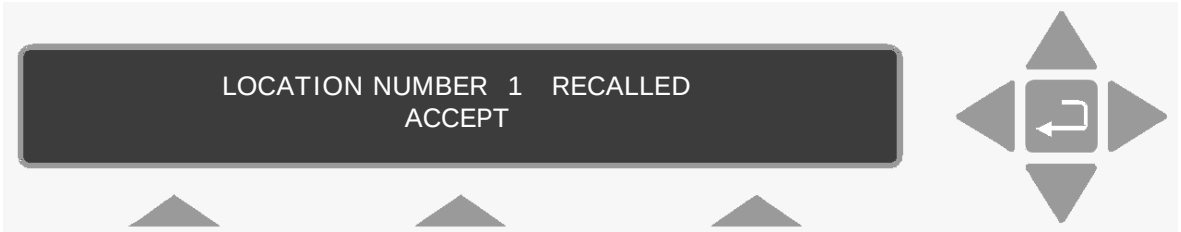
To recall data stored in *Background Memory* to *Display Memory*:

1. Press **Memory** **S2**.



2. Use the direction keys to select the correct location number. The following text is displayed.

3. If you want to continue, press **S1**, and the following text is displayed.



If you want to Stop, press **S3**, this returns you to the original display showing **SELECT MEMORY FUNCTION** so that you can **STORE** any data which is stored in *Display Memory* as explained in section 11.3.1.

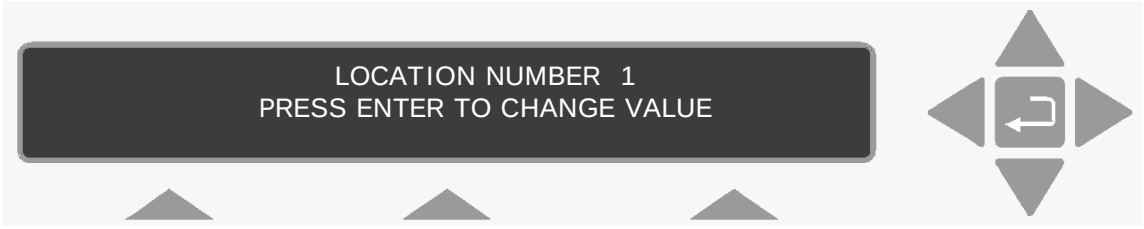
4. Press **S2**. If data has not been stored in the chosen location, a message will appear on the Monitor's display to inform the user. Otherwise, the data from the chosen location in *Background Memory* will be copied into *Display Memory*.

5. Press **MEMORY** to exit.

11.3.3 Deleting Data from Background Memory

To delete data which has been stored in *Background Memory*:

Press **MEMORY** **S3**.



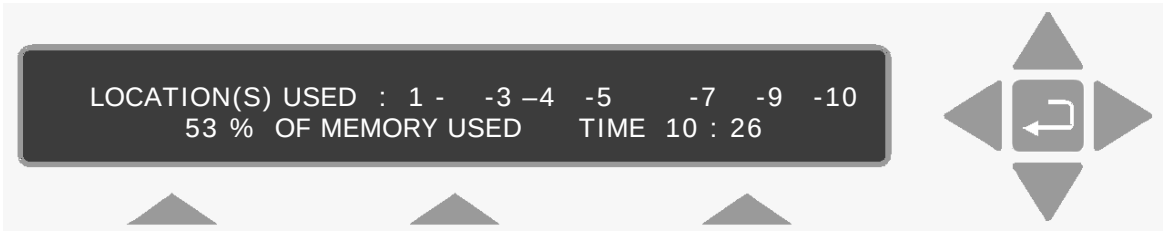
Use the direction keys to select the location number. After selecting the chosen location number the display will show the starting-time of the oldest data stored in the *Background Memory*:

If the starting-time of the oldest stored data to be deleted corresponds with the starting-time shown on the display screen then press **S1** and then **S2** to accept that the data will be deleted from *Background Memory*.

11.3.4 Obtaining Information in Memory Mode

It is not necessary for the user to remember the numbers of the locations in *Background Memory* which have been used to store data. When the Monitor is operated in Memory **mode**, users can at any time find out which locations are used, and what percentage of the *Background Memory's* total data capacity has been used by:

Pressing the **INFO** push-button:



The numbers appearing on the above display are those, which contain stored data. The Monitor will show the above "Information text" display for a short period of time and then automatically change back to the text, which was showing on the display before the **INFO** push-button was pressed.

Chapter 12

Using a Printer with the Monitor

October 2012

12.1 Introduction

This chapter informs you on how to obtain hard copies of data stored in the memory of the monitor. This could, for example, be existing calibration data, which you need prior to recalibrating.

Alternatively, for those of you who want to use the monitor as a stand-alone instrument, this chapter enables you to print-out measurement data, error-logs and data-logs. If any error occurs during any of these operations, a warning will be displayed. All possible errors of this kind are listed in Chapter 17.

The Monitor has four interface ports on its back panel, an IEEE 488 and a RS-232, which can be used for printing. This means that any standard text printer with one of these interfaces can be used to print-out data from the Monitor. Data can be printed out while the Monitor is operating – using the **Data-logging** facility. This means that during a monitoring task or during a calibration task the Monitor will automatically send measurement results to the printer as soon as they are available (see section 12.5). Any operational errors or warnings that occur during a monitoring task can also be automatically printed out using the **Error-logging** facility. Alternatively, when the Monitor is not being operated in any mode, data can be printed out using the **PRINT** button. Data can be printed out in three different blocks:

1. **Measurement:** this block contains the measurement data displayed on the Monitor screen during the printing operation – it also provides the set-up parameters for the displayed monitoring task (see section 9.2).
2. **Set-Up:** this block contains **active** set-up parameters.
3. **Calibration:** this block contains the optical filter factors, calibration factors and all other information related to the calibration of the optical filters installed in the Monitor.

Note: if you want to use the interface ports for data transfer other than to a printer, or a PC equipped with the Gas Monitoring Software 7304 or the On line LumaSoft Gas 7810 SW an Interface Manual, which explains the protocol messages in details, is available.

12.2 Printer Cables

To connect the cables:

1. Ensure that both the Monitor and the printer are switched off at the mains. Failure to do so may result in your equipment being damaged.

2. Locate the desired port at the back of the monitor. The ports are labelled “RS-232” and “IEEE”.

3. Push the cable connector on to the correct socket, and secure it firmly using the securing screws.

4. Locate the input port on the printer.

5. Push the connector at the other end of the cable on to this socket, and secure it firmly using the securing screws.

The instruments can be turned on at the mains now.

12.3 Setting-up Communication Parameters

WARNING!: You must perform a **PARTIAL RESET** of the Monitor (press the **RESET** and **S1** buttons) if the **active** value of any parameter in this branch of the Set-Up Tree is changed. If the Monitor is not partially reset, then, the Monitor will not up-date the communication-parameter data which was used last time data was transmitted via either of its interfaces. By performing a partial reset you ensure that the Monitor has the parameters necessary to enable it to transmit data to the attached printer.

Press **SET-UP** **S3** **S1** **S3** and the following text is displayed:

SELECT COMMUNICATION SET-UP BRANCH		
RS 232 C	ADDRESSABLE	CONNECTIONS

If you are using the RS-232 interface, go to section 12.3.1. If you are using the IEEE interface, go to section 12.3.2.

12.3.1 RS-232 Interface

A brief description of the communication parameters is given below. A list of the parameters, together with the values available and their factory default values are shown in Table 12.1.

The parameters in this branch decide how the Monitor communicates via the RS232 interface.

SELECT BAUD RATE gives the rate at which data should be transmitted from the Monitor via its RS-232 interface.

SELECT NUMBER OF STOP BITS gives the number of stop bits, which should be used when data is transmitted from the Monitor to other equipment.

SELECT NUMBER OF DATA BITS gives the number of data bits, which should be used when data is transmitted between the Monitor and other equipment.

SELECT PARITY CHECK The user chooses whether or not transmitted data should be checked for transmission errors using the parity checking system.

SELECT HARDWIRE MODE The user chooses which communication line (wire) should be used to control data transmission between the Monitor and other equipment.

SELECT HANDSHAKE TYPE The user chooses which type of "handshake" should be used for transmission via the RS 232 interface.

Table 12.1 The available choices and the default values for each RS-232 communication parameter

Display Text	Acceptable Values	Default Value
SELECT BAUD RATE	300/600/1200/ 2400/4800/9600	9600
SELECT NUMBER OF STOP BITS	1 BIT, 2 BITS	1 BIT
SELECT NUMBER OF DATA BITS	7 BITS, 8 BITS	7 BITS
SELECT PARITY CHECK	NONE, EVEN, ODD	EVEN
SELECT HARDWIRE MODE	Three-wire, Switched-line, Leased-line	Leased-line
SELECT HANDSHAKE TYPE	None, X-ON/X-OFF, Hard-wired	Hard-wired

REMEMBER to partially reset your Monitor if any of the above parameters are changed! See the WARNING at the beginning of section 12.3**.**

From the top of the Communication branch of the Setup Tree

SELECT COMMUNICATION SET-UP BRANCH
RS 232 C ADDRESSABLE CONNECTIONS

1. Press **S1**. (RS 232 C)

2. Use the direction and select push-buttons to select the correct values for the parameters.

If you are in doubt about any of the settings, refer to your printer manual.

3. When you have been through all the parameters, the monitor returns to the top of the ***Communication*** branch of the Set-Up Tree.

4. Press **S3** **S1** and then **SET-UP**. This selects the RS-232 port as the communication port for the printer.

5. Press **RESET** and **S1** to partially reset your Monitor.

12.3.2 IEEE Interface

The parameters in this branch decide how the Monitor communicates via the IEEE 488 interface bus.

Monitors 1314i's ADDRESS 14 This enables the Monitor to be addressed via the IEEE 488 interface. The range of acceptable values and the factory default value of the Monitor's address are shown in Table 12.2.

Table 12.2 The range of acceptable values and the default value of the Monitor's address

Display Text	Acceptable Values	Default Value
1314i ADDRESS	from 0 to 100	14

The other IEEE 488 communication parameter which need to be selected in this branch of the Set-Up Tree is shown in Table 12.3 together with available choices and the factory default value.

Table 12.3 The range of acceptable values and the default value of the IEEE 488 communication parameter

Display Text	Acceptable Values	Default Value
IS 1314i SYSTEM CONTROLLER?	NO, YES	YES

IS 1314i SYSTEM CONTROLLER? The user chooses whether or not the Monitor will be the system controller on the IEEE 488 interface bus.

REMEMBER to partially reset your Monitor if any of the above parameters have been changed! See the WARNING at the beginning of section 12.3**.**

From the top of the ***Communication*** branch of the Set-up Tree:

SELECT COMMUNICATION SET-UP BRANCH		
RS 232 C	ADDRESSABLE	CONNECTIONS

1. Press **S2**. (ADDRESSABLE)

SELECT ADDRESABLE SET-UP BRANCH	
TCP/IP	IEEE 488

2. Press **S3**. (IEEE 488)

3. Use the direction push-buttons to select the correct values for the parameters.
   If you are in doubt about any of the settings, refer to your printer manual.

4. When you have been through all the parameters, the monitor returns to the top of the ***Communication*** branch.

5. Press **S3** **S3** and then **SET-UP**. This selects the IEEE port as the communication port for the printer.

6. Press **RESET** and **S1** to partially reset your Monitor.

12.4 Additional Parameters Required

The other output parameters which determine the format of print-outs are shown in Table 12.4 together with available choices and factory default values.

Table 12.4 Parameters which determine the format of print-outs from the monitor

Display Text	Acceptable Values	Default Value
PRINT EACH GAS?	No, Yes	Yes
(if print each gas is no) PRINT GAS N*?and/or Air Pressure	No, Yes	No
SELECT TEXT LINE TERMINATOR	CR, LF, CR-LF	CR-LF

If one chooses to **PRINT EACH GAS**, then all gases, which have been measured, will be printed out. If one does not choose to **PRINT EACH GAS** then the user is given the chance to choose which of the gases (A-E) and water (W) should be printed out – **PRINT GAS A?** and so on.

SELECT TEXT LINE TERMINATOR The user chooses which character the Monitor should use as “end of text line” when data is transmitted from the Monitor.

12.5 Data Logging Function

Setting-up the Monitor to Print a Data Log

If the Monitor is connected up to a printer, and it is set-up to transmit data to the printer, this function enables measurement data to be printed out, automatically, as soon as it becomes available during a measurement or calibration.

The procedure is as follows:

4. Press the following sequence: **SET-UP** **S3** **S1** **S1**, and the following text is displayed:

SELECT GENERAL SET-UP BRANCH ?		
CLOCK	SOUND	TESTS

5. Press **S3** ▼ **S3** **SET-UP**. This activates the data logging function.

12.6 Error Logging Function

Setting-up the Monitor to Print an Error Log

If the Monitor is connected up to a printer, and it is set-up to transmit data to the printer, this function enables any warning or error messages that are displayed, to be recorded in the printed error log, automatically.

The procedure is as follows:

1. Press the following sequence: **SET-UP** **S3** **S1** **S1**, and the following text is displayed:

SELECT GENERAL SET-UP BRANCH ?		
CLOCK	SOUND	TESTS

2. Press **S3** ▼ ▼ **S3** **SET-UP**. This activates the error logging function.

12.7 Printing-out Data from the Monitor

Before data can be printed out from the Monitor, the communication parameters must be checked/changed. This is explained in section 12.3.1 for RS-232 communication and section 12.3.2 for IEEE communication. The text line terminator must be set (see section 12.4) before printing can proceed.

Setting the Data Logging function is described in section 12.5.

12.7.1 Starting a Print-out

Press **PRINT** and then one of select push-buttons **S1** **S2** or **S3** depending on which data block you wish to print-out.

12.7.2 Stopping a Print-out which is in Progress

If a print-out is in progress and you wish to stop it, then the following steps need to be followed:

1. Press the **PRINT** button on the Monitor's front panel.
   The following text will appear on the display:

PRINT ABORTING **PLEASE WAIT**

   The printer will stop printing data.

2. Use the Line Feed function on the printer if the paper is not ejected automatically.

Chapter 13

Maintenance of the 1314i

October 2012

The only regular maintenance required for the 1314i is:

Calibration – approximately every 3 months (see Chapter 14).
Changing the fine air-filter paper in the internal and external air-filtration units (see section 13.1).
Cleaning of the filter in the ventilation unit (see section 13.2).

13.1 Changing the Fine Air-filters

The monitor is equipped with an ***internal*** filtration unit.

The ***internal*** unit is mounted on the air-inlet, on the back panel. This is shown in Fig.13.1.

Fig.13.1 The internal air-filtration unit mounted on the back panel of the monitor.

The internal air-filtration unit can be removed simply by unscrewing the unit by hand. The unit is shown in Fig.13.2.

Fig.13.2 The internal air-filtration unit

Inside the unit, a fine (10µm) filter-paper removes fine dust particles and other suspended matter from air samples before they reach the measurement chamber of the Monitor.

Whenever the Monitor needs to be calibrated, we recommend that the fine filter-paper in the internal air-filtration unit is changed **before** you calibrate. The fine filter-paper in the internal air-filtration unit must be changed at least twice a year; and more frequently if the environment in which the monitor is working contains large quantities of particulate material suspended in the air.

When the monitor is making measurements, we recommend that a length of Teflon® tubing (of up to 50 metres in length) is always attached to the stub of the air-inlet (see Fig.13.1) and that the special *external* air-filtration unit UD 5023 (optional accessory), shown in Fig.13.3, is always attached to the free-end of the sampling tube, by means of the small stub. An external coarse metal air-filter prevents large particles, insects etc. being drawn into the unit, while inside the unit is a fine (10µm) filter-paper, which prevents any finer particles from entering the Teflon® sampling tube. The fine filter-paper in this unit must **also** be changed regularly – at least as frequently as the fine filter-paper in the internal fine air-filter.

Fig.13.3 The external air-filtration unit UD5023 used with the Monitor, (optional accessory)

Changing the fine filter-paper in both the internal and external air-filtration units is explained step by step in the following two sub-sections.

13.1.1 Changing the Filter-paper in the Internal Air-filtration Unit

While you do this, we recommend that you wear clean, rubber gloves.

Tools and equipment required:

Acetone (analytically pure)
Spare fine filter-paper DS 0759
Tweezers with Teflon coating
Cotton buds
Clean rubber gloves

To change the filter-paper:

Switch the power to the monitor “Off” by using the AC mains power switch on its back panel (press O), and then pull out the plug connecting the monitor to the AC mains power supply.
Put a rubber glove on the hand, which is to hold the parts of the unit.
Unscrew the internal air-filtration unit from its mounting on the air-inlet, see Fig.13.1. To do this, turn the unit anti-clockwise with your fingers until the unit is free of the slot.
The unit is removed from the monitor. It is shown in Fig.13.2.
Use the tweezers to lift off the retaining disc and used filter-paper, while holding the handle of the unit between your thumb and fingers. Refer to Fig.13.4. The retaining disc has two tabs which “lock” it to the filtration unit.

Fig.13.4 Removing the retaining disc and old filter-paper

Holding the disc with the tweezers, moisten a cotton bud with pure acetone and use it to clean the surfaces of the disc. Place the disc on a clean, dry surface.

Caution: Make sure that no cotton fibres remain on the mesh of the retaining disc otherwise they could be sucked up into, and block the measurement system when the Monitor is operated.
Hold the handle-end of the unit between your thumb and fingers. Moisten a cotton bud with pure acetone and use it to clean the surfaces of the unit. Refer to Fig.13.5. Place the unit, with its handle-end downwards, on a clean, dry surface.

Fig.13.5 Cleaning the surfaces of the internal air-filtration unit

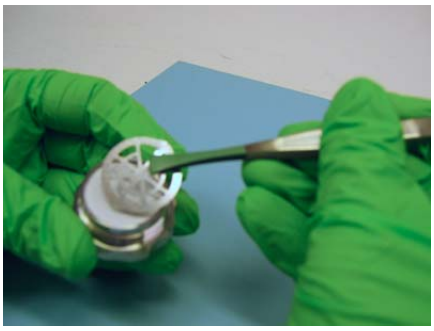
Notes:
Only proceed to the next step when the acetone has completely evaporated from the air-filter retaining disc and filtration unit.
Each of the fine filter-papers DS 0759 are packed between two pieces of packing paper. The fine filter-paper is always white in colour.

Remove a new fine filter-paper from its packaging using the tweezers. Hold it by its edge. Refer to Fig.13.6. Lift the filter up and place it inside the unit.

Fig.13.6 Placing a new filter-paper in the unit

Holding the handle-end of the unit between your thumb and fingers, pick up the (dry) retaining disc and place it over the new filter-paper. Refer to Fig.13.7. Gently press the disc down over the filter-paper, making sure that the disc's locking tabs fit properly into the groove in the unit and that the filter-paper stays in position and is not damaged in any way.
Holding the handle-end of the re-assembled unit between your thumb and fingers, place it back into position in the air-inlet of the Monitor. Screw it back into its mounting. To do this, turn the unit clockwise with your fingers to tighten until it is in position.

Fig.13.7 Refitting the retaining disc



13.1.2 Changing the Filter-paper in the External Air-filtration Unit

While you do this, we recommend that you wear clean, rubber gloves.

Tools and equipment required:

Acetone (analytically pure)
Spare fine filter-paper DS 0759
Tweezers with Teflon coating
Cotton buds
Clean rubber gloves

To change the filter-paper:

Switch off the Monitor.
Put a rubber glove on the hand which is to hold the parts of the unit.
Pull the external fine air-filtration unit off the end of the Teflon® sampling tube. Hold the stub-end of the external air-filter unit between your thumb and fingers, and unscrew the coarse air filter from the end of the unit. Refer to Fig.13.3.
Remove the used (old) filter-paper and the retaining disc from the unit using the tweezers. Refer to Fig.13.8.

Fig.13.8 The parts of the external air-filtration unit UD 5023

Moisten a cotton bud with pure acetone and use it to clean the surfaces of the unit, the retaining disc and the coarse air-filter. Refer to Fig.13.8. Place the stub-end of the unit downwards, on a clean, dry surface; the coarse air-filter, with its screw-end downwards on a clean, dry surface and rest the retaining disc against it.

Caution: Make sure that no cotton fibres remain on the mesh of the retaining disc otherwise they could be sucked up into, and block the measurement system when the analyzer is operated.

Notes:
Only proceed to the next step when the acetone has completely evaporated from the cleaned surfaces.
Each of the fine filter-papers DS 0759 are packed between two pieces of packing paper. The fine filter-paper is always white in colour.

Hold the stub-end of the unit between your thumb and fingers. Lift the retaining disc with the tweezers and place it back into position in the unit. Refer to Fig.13.8.
Remove a new fine filter-paper from its packaging using the tweezers. Hold it by its edge. Carefully place the filter-paper over the top of the retaining disc so that it is held in position by the small “lip” on the rim of the unit.

Screw the coarse air-filter over the end of the external air-filtration unit. Make sure that the fine filter-paper remains in its correct position directly over the retaining disc.

13.2 Cleaning the Filter in the Ventilation Unit

A small ventilation unit is mounted on the back panel of the Monitor (see in Fig.13.9). The ventilating fan in this unit circulates air through the Monitor to keep it cool. To ensure that the air being drawn into the Monitor is free of particles a filter pad is placed between the fan and grid which covers it. This filter needs to be periodically taken out and cleaned. We recommend that this task is done at least as often as calibration, and more frequently if the Monitor is working in a very dusty atmosphere or an atmosphere containing high concentrations of other particulate matter.

Use a “pozidrive” screwdriver to unscrew the screw on the grid cover. Remove the filter pad from inside the grid cover. Wash the filter pad in warm water containing some liquid soap. Rinse all the soap out of the filter, by running clean water through it, and let it dry **thoroughly**.
Place the clean, thoroughly dry, filter pad inside the grid cover. Screw the grid cover firmly back in place over the ventilation unit.

Fig.13.9 Back panel of the 1314i showing the ventilation unit

13.3 Cleaning the Instrument

It is recommended to clean the instrument using a damped cloth.

Chapter 14

Calibration of the Optical Filters

October 2012

14.1 About the Installed Optical Filters

In collaboration with LumaSense Sales Engineers, you have chosen the optical filters that are best suited to your measuring task. Each of these optical filters has been installed in one of the positions marked “A”, “B”, “C”, “D” or “E” of the filter carousel wheel in your Monitor. A special optical filter, which is selective to water vapour, is always installed in position “W”.

Each optical filter has to be **span calibrated** with the gas it is to measure. If this **span calibration** is not performed the Monitor is unable to measure accurately.

Each filter in the carousel has to be **fully** calibrated before the Monitor can perform accurate gas measurements. The practical calibration procedure is fairly simple, it involves performing measurements with the Monitor while various gas supplies are attached to its air-inlet.

A **full** calibration of the water-vapour filter SB 0527 involves:

- **Zero-point calibration** (using a zero-gas*)
- **Span calibration** (using a known concentration of water vapour)

A **full** calibration of the optical filters in position “A” to “E” involves:

- **Zero-point calibration** (using a zero-gas*)
- **Humidity-interference calibration** (using water-vapour)
- **Span calibration** (using a known concentration of the gas this filter is to measure)
- **Cross-interference calibration** (when this is necessary). If the gas to be measured by filter “A” actually absorbs light from any of the other installed optical filters it will interfere with the signal measured when the other optical filters are used. If this is the case, it is necessary to perform a cross-compensation calibration of this filter. This involves taking measurements with all the other installed optical filters while the span calibration is performed.

The following sections explain what a calibration is and why it is necessary. Some of the expressions used in this chapter are also explained, to help you understand the process.

* A zero-gas is a gas which does not absorb infra-red light e.g. pure Nitrogen.

14.2 What is Calibration and Why is it Necessary?

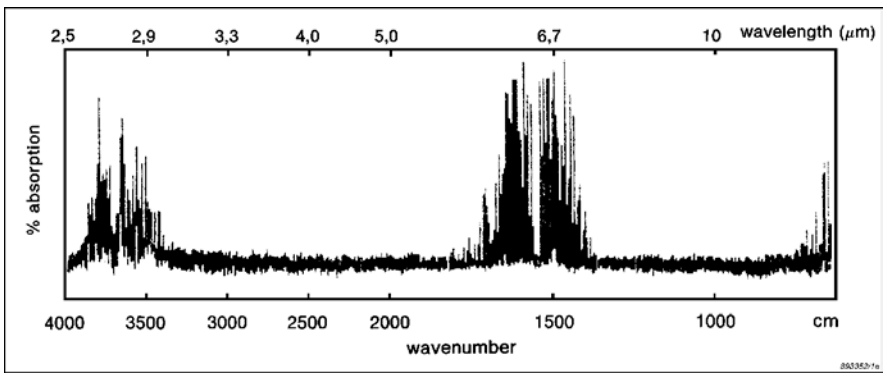
In order to understand calibration, it is necessary to look at what happens inside the analysis cell during a gas concentration measurement. A sample of air is drawn into the cell. The cell is then sealed off and light is sent from the infra-red source via a chopper (to pulsate it) through an optical filter. The optical filter only transmits light in a defined wavelength range and this light enters the cell.

If there is a gas in the cell, which absorbs light of this wavelength, a pressure wave is created and this is measured by the microphones mounted within the cell. The greater the concentration of the absorbing gas in the cell, the greater the pressure (sound) wave it creates.

How do we measure the relationship between the measured sound signal and the concentration of the absorbing gas in the cell? We calibrate the optical filter.

Our description of what happens in the cell is, however, a little too simplified. In reality, we have to take three other factors into consideration: namely: (1) cell noise; (2) the presence of water vapour in the sample (humidity interference); and (3) the possible presence of other interferent gases.

Fig.14.1 High resolution absorption spectrum of water vapour



Cell Noise

When there is zero-gas in the cell (that is, a gas which does not absorb any infra-red light) a signal is measured in the cell. This signal is due to what is termed **cell noise**. Cell noise is created by the imperfect reflection of infra-red light from the cell walls. It is dependent upon the properties of the cell itself (for example, its dimensions and the reflectivity of its walls) as well as the wavelength

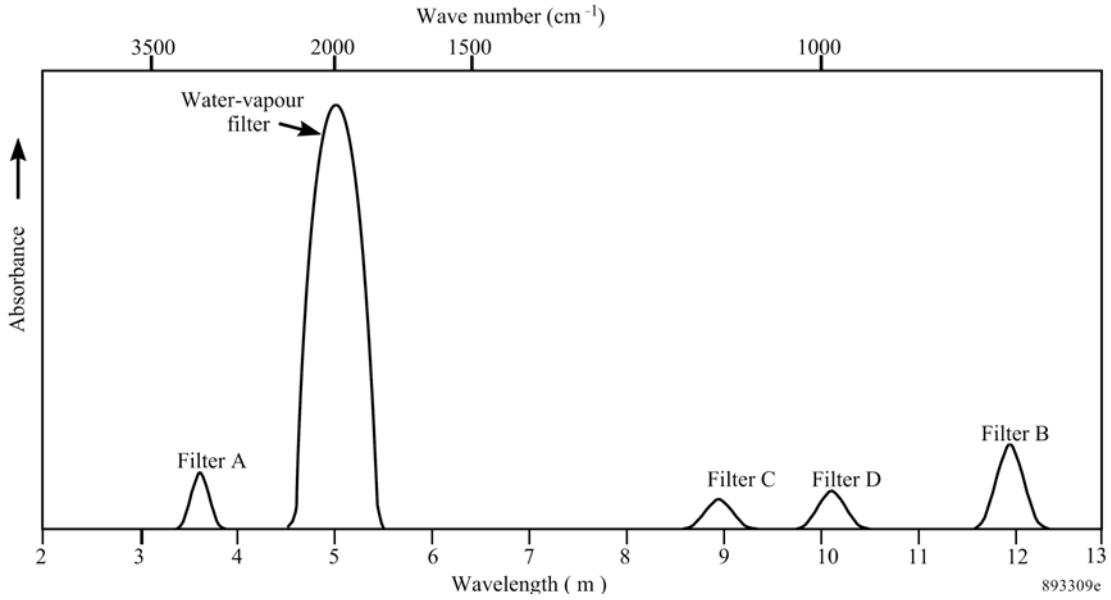
(and thus energy) of the infra-red light which is incident on its walls. As it is the optical filter, which determines the wavelength of light, cell noise will depend upon the optical filter being used.

The cell-noise signal is measured during the **Zero-point Calibration** of each filter. A supply of dry, zero gas is attached to the air-inlet of the Monitor and the signal in the cell is measured with each installed optical filter ("A" to "E"). This signal is called the **concentration offset factor** for the filter. Whenever the filter is used, this signal is subtracted from the total measured signal as it is not related to the concentration of any gas.

Presence of Water Vapour

Water vapour is nearly always present in ambient air and it absorbs infra-red light, to a greater or lesser extent, at nearly all wavelengths (see Fig.14.1). This means that no matter which optical filter is transmitting light into the cell the water vapour in the cell will absorb some of this light and create a signal. This signal is said to "interfere" with the signal produced by the gas we wish to measure with this filter.

Fig.14.2 Schematic diagram showing the relative absorption of water vapour by different optical filters

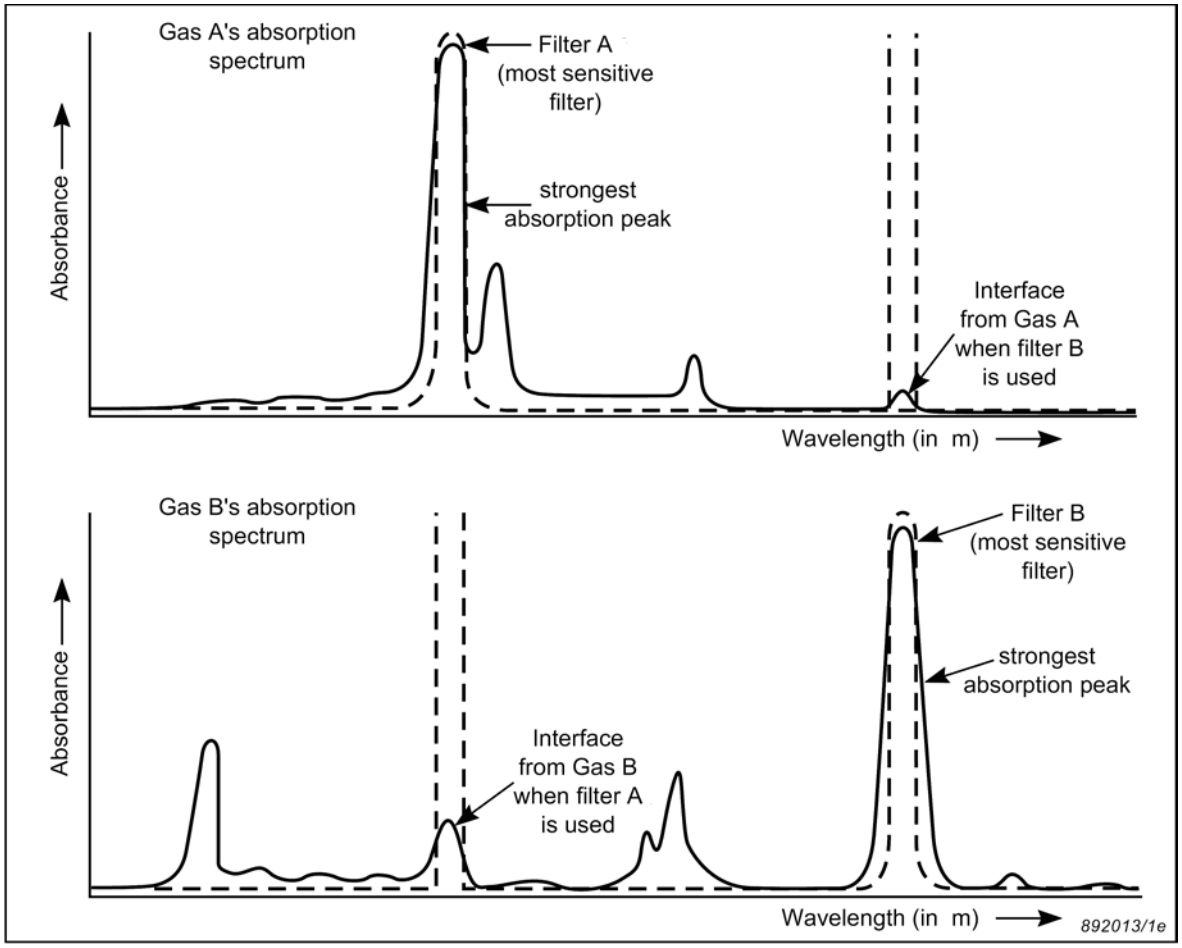


How is this interference measured? A water-vapour optical filter, which transmits light with a wavelength, which is absorbed by very few gases, except water vapour, is always installed in position "W" of the filter carousel. Using this filter, water-vapour's interference is measured during the **Humidity Interference Calibration** of each installed filter. A supply of zero gas containing a constant concentration of water vapour is attached to the air-inlet of the

Monitor. The signal in the cell is measured with the water vapour filter and with **all** the other installed optical filters.

The water vapour in the cell absorbs light from the water-vapour filter and from the other installed filters, producing signals which are related to water-vapour's relative absorption of the light at the wavelengths transmitted by the different optical filters (see Fig.14.2). We know, however, that the ratio of the signal measured with any one filter (e.g. "A") and the signal measured with the water-vapour filter is a constant. This ratio is related to the **Humidity Gain Factor** calculated during the humidity-interference calibration of filter "A". For example, if the signal produced by water vapour when using the water-vapour filter, is 160µV and using Filter "A" is 16µV, then, if the signal measured with the water-vapour filter is found to be 80µV, we know that this concentration of water vapour will produce a signal of 8µV when Filter "A" is used. Measurements made during humidity-interference calibration of the installed filters therefore enable the Monitor to compensate any measured signal for water-vapour's interference.

Fig.14.3 Schematic diagram showing the absorption spectrum of gas A and gas B. The dashed lines represent the half-power bandwidths of the filters used to measure each gas



Presence of Other Interferents

In many measurement situations water vapour is not likely to be the only interferent present. Suppose that you have installed an optical filter “A” to measure a gas (A), but another gas (B) is normally found in the ambient air you are monitoring. If gas B absorbs some light from filter “A”, it will “interfere” with the signal produced by gas A’s absorption of this light. This is illustrated by the lower absorption spectrum in Fig.14.3 (“Interference from Gas B when filter A is used”). This interference is termed **cross interference**.

How is this interference measured? An optical filter “B” is chosen, which transmits light with a wavelength which is most strongly absorbed by gas B, and less strongly by gas A, this is illustrated by the lower absorption spectrum shown in Fig.14.3. During cross **interference calibration** two sets of measurements are performed:

1. The signal in the cell is measured using filter “A” and the filter “B” when a known concentration of gas A is in the analysis cell. The ratio of these two signals is directly related to gas A’s relative absorption of light at these two wavelengths (upper spectrum in Fig.14.3). This ratio is a constant and is a measure of **Gas A’s Interference on filter “B”**.

2. The signal in the cell is measured using filter “A” and filter “B” when a known concentration of gas B is in the cell. The ratio of these two signals is directly related to gas B’s relative absorption of light at these two wavelengths (lower spectrum in Fig.14.3). This ratio is a constant and is a measure of **Gas B’s Interference on filter “A”**.

By measuring the ratios described above, the Monitor is able to compensate any measurement made with filter “A” for any interference signal produced by the presence of gas B in the cell, and vice versa. This procedure is known as **cross compensation**.

14.3 Tasks Before Starting Any Calibration

Before starting any kind of calibration task there are several operations, which need to be performed:

14.3.1 Obtaining a Print-out of Calibration Data in the Monitor

PC Use

Whether the Monitor is to be used online or as a stand-alone instrument, the Gas Monitoring Software 7304 can be used to check the Monitor’s existing calibration. All the calibration factors can be printed out directly from the software using the “Print Current Calibration (see section 8.6.2).

Stand-alone Use

With the monitor connected to a printer (details are given in Chapter 12):

Press **PRINT** and then **S3**.

To stop printing, press **PRINT** again.

14.3.2 Checking the Calibration of Each Installed Optical Filter

A print-out of the calibration data in the Monitor's memory is useful to have for reference. It also enables you to find out how "old" calibration factors compare with the "new" calibration factors calculated during re-calibration tasks, see section 14.3.1.

Fig.14.4 illustrates only part of a typical calibration data print-out. To simplify our discussion, we will confine our discussion to the calibration data for a single optical filter installed in position "A". Note that there are **five** different filter banks, which contain calibration data. These banks are numbered from 1 to 5. This enables each filter to be calibrated to measure up to 5 different gases. Before the filter is calibrated to measure any one particular gas, you have to inform the Monitor about where you wish to store the calibration data for this gas. The number of the filter bank chosen when operating in **Set-Up mode** is called the **active** filter bank (see Chapter 11).

When checking the optical filters using the front panel push-buttons, Chapter 12 provides details of how to obtain a print-out of calibration data using a printer with an RS 232 interface or an IEEE 488 interface.

Note that calibration data in the active filter bank is always printed out directly after the optical filter factors data and this data is also shown under the **heading CALIBRATION DATA IN FILTER BANK : X**, where X is the number of the filter bank.

Note: all calibration factors are expressed as exponential numbers. For example: 104.05E-3, this is the same as the number 104.05 x 10-3 = 0.10405

1. Refer to your calibration data print-out and check the following information:

   a. Under the **heading GENERAL CALIBRATION INFORMATION FOR FILTER A:** check that the UA number of the installed optical filter is the same as the UA number appearing on the "Calibration Chart" for the optical filter in position "A".

      Under the headings **CALIBRATION DATA IN FILTER BANK:1**; **CALIBRATION DATA IN FILTER BANK:2**; **CALIBRATION DATA IN FILTER BANK:3**; **CALIBRATION DATA IN FILTER BANK:4**; and **CALIBRATION DATA IN FILTER BANK:5** check the following information:

b. **Zero-point calibration performed:** if a date appears here (**year-month-day**) this is the last time the zero-point calibration data in this filter bank was updated.

c. **Concentration offset factor:** if a number appears here this means that this filter bank contains calibration data obtained during a zero-point calibration of filter “A”.

d. **Hum. Interference Calibration performed:** if a date appears here (**year-month-day**) this is the last time the humidity-interference calibration data in this filter bank was updated.

e. **Humidity gain factor:** if a number appears here this means that this filter bank contains calibration data obtained during the humidity-interference calibration of filter “A”.

f. **Cross Interference Calibration performed:** if a date appears here (**year-month-day)** this is the last time cross interference calibration data in this filter bank was updated.

g. **“Gas name” interference on Filter B, C, D, E:** if a number appears after these headings this means that this filter bank contains calibration data collected during cross-interference calibration for this named gas.

h. If the following three conditions are found in any filter bank:
- **Gas name:** if the name which appears here is the same as the name of the gas you intend to measure with filter “A”;
- **Span Calibration performed:** if a date appears here; and
- **Conversion factor:** a number appears here;

then this filter has been properly span calibrated with the named gas. The **filter bank** containing this calibration data is the filter bank, which has to be made **active** when filter “A” is to measure this named gas.

i. However, if the **Gas name:** is given as “Gas UA number” then the filter has only been checked to see that it is functioning correctly, it has **not** been **span calibrated** to measure the gas you wish to measure.

2. Under the heading **GENERAL INFORMATION FOR WATER FILTER – ACTIVE CALIBRATION DATA :** check the following information:

a. **Zero-point Calibration performed:** if a date appears here this is the last time the water-vapour filter was zero-point calibrated.

b. **Concentration offset factor:** if a number appears here this means that the water-vapour filter has been zero-point calibrated.

c. **Span Calibration performed:** if a date (**year-month-day**) appears here, this is the last time span calibration of the water-vapour filter was performed.

d. **Conversion Factor:** if a number appears here this means that the water-vapour filter has been span calibrated.

When the water-vapour filter has been zero-point calibrated **and** span calibrated it is able to measure the absolute concentration of water vapour in any gas sample in the analysis cell of the Monitor, and it requires **no** further calibration.

When all installed optical filters (in positions “A” to “E”) have been zero-point, humidity-interference, span and cross-interference calibrated (if necessary) then the Monitor is able to perform accurate measurements.

Fig.14.4 Part of a calibration data print-out

```
- 1314i Calibration Data ------ 701-002/9312 - 2011-06-18 11:40 - Page  1 -

GENERAL CALIBRATION INFORMATION FOR FILTER A.
--------------------------------------------------------------------------------

Installed Optical Filter                :          UA0984
Active Filter Bank Number               :               1


OPTICAL FILTER FACTORS
--------------------------------------------------------------------------------
Back. temp. factor                      :      1.8067E-03
Conc. temp. factor                      :      8.9662E-03
Hum. temp. 1 factor                     :      -1.039E-03
Hum. temp. 2 factor                     :      51.138E-03
Hum. temp. 3 factor                     :      0.0000E+00
Hum. sqr. factor                        :      -239.0E+00
Hum. cub. factor                        :      0.0000E+00


ACTIVE CALIBRATION DATA
--------------------------------------------------------------------------------
Gas name : Carbon monoxide
Molecular weight                        :      28.010E+00
High Alarm Limit 1                      :         15.0000 ppm
High Alarm Limit 2                      :         30.0000 ppm

Span Calibration performed              :      2011-06-18
Type of Span Calibration                :    Single Point
Conversion factor                       :      651.49E+03
Concentration                           :            57.0 mg/m3
Microphone Signal                       :            98.0 uV

Zero-Point Calibration performed        :      2011-06-15
Concentration offset factor             :      4.9803E-06
Microphone Signal                       :            5.16 uV

Hum. Interference Calibration performed :      2011-06-15
Humidity gain factor                    :      77.392E-03
Microphone Signal                       :            19.5 uV

Cross Interference Calibration performed :     2011-06-18
Carbon monoxide interference on :
Filter B                                :      0.0000E+00
Filter C                                :      __________
Filter D                                :      __________
Filter E                                :      __________
```

14.3.3 Checking and Changing Optical Filter Parameters

Before starting calibration it is always wise to check that information about the installed optical filters has been “entered” **correctly** in the **active** set-up of the Monitor. If the **incorrect** UA number is “entered” for the optical filter in a particular position, the incorrect optical filter factors will be used in the calculation of the calibration factors, and calibration will therefore be useless.

The UA number can only be changed using the push-buttons on the front panel of the monitor.

1. Press **SET-UP** **S3** **S3**.
   The following text appears on the screen display:

CHECK AND / OR CHANGE SET-UP FOR FILTER A
NO YES

2. Press **S3** and the following text appears on the screen display:

SELECT UA NUMBER FOR FILTER A 0984
PRESS ENTER TO CHANGE VALUE

The UA number of the filter installed in position "A" should have already been checked (see section 14.3.2).
WARNING! If this number is changed all calibration data for this filter – in all 5 filter banks – will be deleted (i.e. lost) and the filter will have to be fully calibrated again before it can be used.
If the incorrect filter is selected, press ↵ and use ▲ and ▼ to scroll through the UA numbers, until the correct UA number is displayed.

The procedure divides here. PC users go to step 3. and Stand-alone users go to step 4.

3. Only the Filter UA numbers need to be checked/changed using the monitor's push-buttons. All the other parameters are set when setting up the calibration using the Calibration program.
   Press ↵ and use ▼ until the following text is displayed.

CHECK AND / OR CHANGE SET-UP FOR FILTER B
NO YES

Repeat steps 2 and 3 until the correct UA numbers have been entered for the fitted optical filters. Then exit the Calibration Set-up by pressing **SET-UP**.

4. Press ↵.
   The following text appears on the screen:

FILTER BANK NUMBER 1
PRESS ENTER TO CHANGE VALUE

5. Press ↵, and use ▲ and ▼ to display the number of the filter bank (1-5) where you wish the Monitor to store the calibration factors calculated during the span calibration of this filter using this particular gas.

6. Press ↵.

The following text appears on the screen:

GAS A IS "_ "
PRESS ENTER TO CHANGE VALUE

7. Press ↵ and use the direction push-buttons to enter the desired name.

8. Press ↵ to "accept" the name you have "entered" on the display screen. The following text then appears:

MOLECULAR WEIGHT OF GAS A 1.000
PRESS ENTER TO CHANGE VALUE

9. Press ↵ and use the direction push-buttons to "enter" the molecular weight of the gas to be measured by filter A.

10. Press ↵ to "accept" the molecular weight you have "entered" on the display screen. The following text appears on the screen:

FILTER A SAMPLE INTEGRATION TIME 5 s
PRESS ENTER TO CHANGE VALUE

11. Press ↵, and use ▲ and ▼ to display the desired Sample Integration Time.
There are seven to choose from: 0.5s, 1s, 2s, 5s, 10s, 20s and 50s.

12. Press ↵ to "accept" the selected value.
The following text appears on the screen:

GAS A HIGH ALARM LIMIT 1 _____mg/m^3
PRESS ENTER TO CHANGE VALUE

13. Press ↵ and use the direction push-buttons to enter the desired alarm level.

14. Press ↵ to accept the entered value. Following screen is displayed:

GAS A HIGH ALARM LIMIT 2 _____mg/m^3
PRESS ENTER TO CHANGE VALUE

15. Repeat step 13 and 14 to enter the desired alarm level.

All the parameters for Filter A are now set, and the display moves on to filters B, C, D and E. Repeat steps 2 to 15, excluding step 3.

16. All the parameters for Filter W are fixed except for the Sample Integration Time and the two high Alarm limits.

17. Press ↵ and use ▲ and ▼ to display the desired Sample Integration Time.

18. Repeat step 13 and 14 to enter the desired alarm levels.

19. Press ↵, this returns you to the top of the Configuration Set-up Tree.

14.3.4 Setting-up the Monitor to Print a Data Log

This is only necessary for those of you who do not use the Gas Monitoring Software 7304 to calibrate the Monitor.

During calibration, the calibration gas is drawn into the cell and the microphones measure the signal produced by the gas's absorption of light from the infra-red light source. As soon as a measurement is made it is displayed on the Monitor's screen. Measurement results are constantly updated on the display, but only one set of measurement results are displayed at a time, and no scrolling facility is available to look at previously-displayed results. Therefore, your Monitor should be set-up to print a "Data log" This is described fully in section 12.5.

14.3.5 Warming Up the Monitor

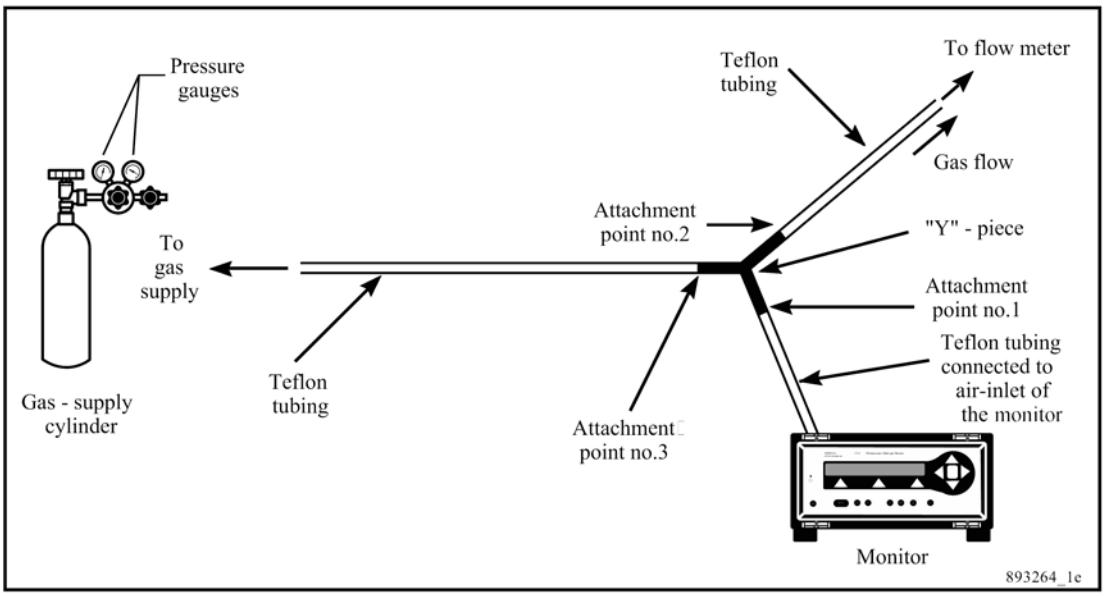
The infra-red light source is very hot and the temperature in the analysis cell thus increases as calibration measurements proceed. Conditions within the cell tend to stabilise more quickly once the temperature inside the analysis cell is 15°C above the ambient room temperature. We therefore suggest that you set-up the Monitor to sample continuously, for a period of 30 – 40 min. to warm up the analysis cell before a calibration task is started. This will reduce the time required for calibration.

To warm-up the Monitor you need to set-up a monitoring task and make the Monitor perform the task for a period of time. If you are unsure about setting up and starting a monitoring task, full instructions are provided together with an example in section 4.3 for stand-alone use.
The Continuous warm function can also be used hence the warm up starts on power on. (see section 5.6).

14.4 The Basic Calibration Set-up

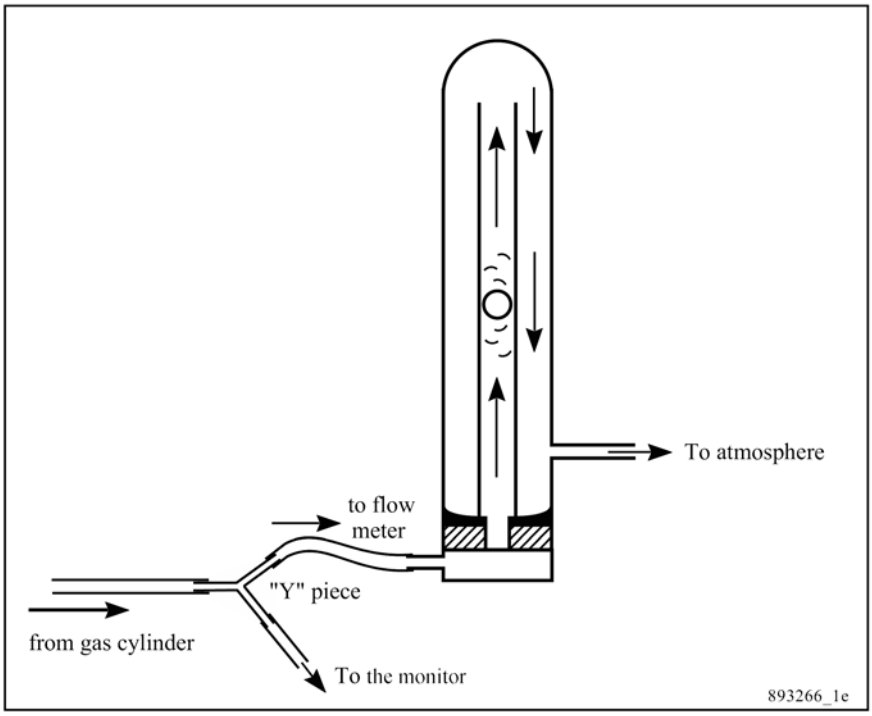
The general equipment required to perform the calibration is shown in Fig.14.5. Three different lengths of teflon tubing are connected to a “Y”-piece. The tube attached to point 1 is connected to the air-inlet of the Monitor; the tube attached to point 2 is attached to a gas flow meter or similar apparatus; and the tube attached to point 3 is attached to the cylinder of gas which is to be used during calibration.

Fig.14.5 General equipment required for a calibration task



Attaching a gas flow meter serves two vital functions (see Fig.14.6):

Fig.14.6 Schematic diagram of a flow meter



- It allows you to have a visually check that there is a net flow of gas **out** of the Teflon tube attached to it during the whole calibration procedure. The “flow ball” can be seen to be bouncing on the upward flow of air out of the meter.
  If the pressure of the gas from the cylinder is too low at any time then the “flow ball” will just remain seated at the bottom of its tube. This condition must be avoided because atmospheric air will be drawn into the Teflon tube system via the flow meter and cause dilution of the calibration gas. This will affect the accuracy of your calibration.

- It functions as an **escape valve**. When the pressure of the gas in the tubing becomes greater than atmospheric pressure, gas flows out to the atmosphere via the flow meter. This ensures that the gas entering the analysis cell is as close to atmospheric pressure as possible, and this prevents damage to the very sensitive microphones in the analysis cell.

WARNING!: The analysis cell of the monitor is equipped with sensitive microphones, and therefore NO direct connection between the Monitor’s air-inlet and the pressure-valve on a gas cylinder is allowed. Under NO circumstances should the pressure of the air in the analysis cell be allowed to exceed 0.1 bar above the ambient pressure.

1. Attach the Teflon tubing to the Air Inlet Filter at the back of the monitor. This is described in detail in section 4.2.

2.
   a. Connect the free-end of the length of tubing attached to the air-inlet to one of the branches of the “Y”-piece (see attachment point no. 1 in Fig.14.5).
   b. Cut off another 1m length of Teflon tubing and connect one of its ends to attachment point no. 2 of the “Y”-piece (see Fig.14.5) and its other end to a flow-meter.

3. Connect a 1m length of tubing to attachment point no. 3 of the “Y”-piece (see Fig.14.5).

14.4.1 Producing a Supply of Clean, Wet Air

When humidity-interference calibrations are performed, clean, wet air is required. This can be produced in the following manner.

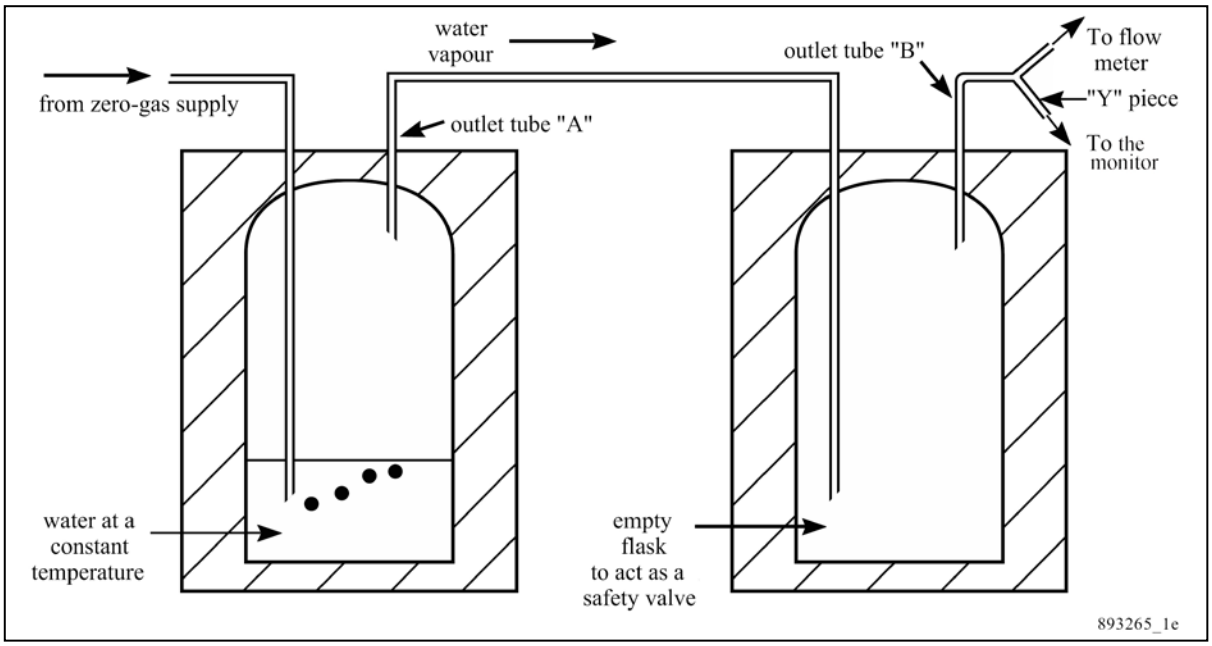
We suggest that you bubble zero-gas (e.g. pure nitrogen) through a thermostatically-controlled water-bath to produce a supply of clean, wet air to the Monitor during humidity-interference calibration of the filters (see Fig. 14.7). Notice that the thermostatically-controlled

water bath is linked up to an extra “empty” flask. This is to prevent a situation where the level of water in the controlled water-bath rises and covers the outlet tube “A” and draws water, via the “Y”-piece, directly into the Monitor’s analysis cell. Water will seriously damage the cell. To avoid such a situation, we suggest that the wet air from the water-bath outlet tube is fed into an extra empty flask before being fed to the air-inlet of the Monitor. Note the length of the respective tubes in the flasks. It is **vitally important** that any water, which collects in the extra flask, does not cover the short outlet tube “B”.

It is very important that the concentration of water vapour used is below the **saturated** water-vapour pressure of the air in the room where calibration is being performed, otherwise water vapour will condense out in the analysis cell. In practical terms this means that:

- The Monitor must have time to reach the ambient temperature of the room before a calibration task is performed.
- The temperature of the water bath you use should be at least 2°C **below** the ambient temperature of the room where calibration is to be performed. So, if your ambient temperature is 20°C, make sure that the temperature of the water-bath you use is set at a maximum of 18°C.

Fig.14.7 Schematic diagram of the equipment necessary to produce a supply of clean, wet air.



14.5 General Settings for a Calibration – 7304 PC Use

The procedures in the following sections assume that all the preliminary tasks described in section 14.3 and section 14.4 have been completed.

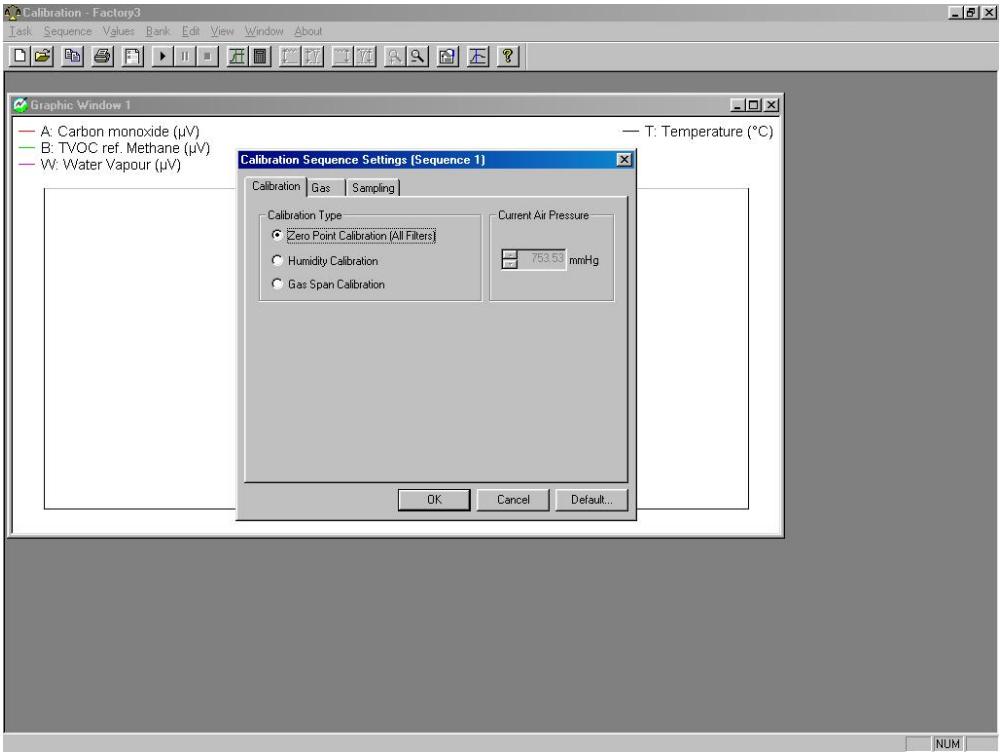
Although there are four types of calibration, many of the procedures for these calibrations are similar. These similarities are described here. Things that are particular to the individual calibrations are described in more detail in the relevant sections. The basic calibration can be divided in to 3 stages:

- Measuring Raw Data
- Calculating Calibration Values
- Downloading the Calibration Values to the Filter Banks

14.5.1 Measuring Raw Data

With the Calibration program already running and the correct tubing attached:

Fig.14.8 Calibration Sequence Settings dialogue



1. Pull down the **Task** menu and click on **New**. If you want to use an existing task then click on **Open**. The Calibration Task dialogue is displayed.

2. Type in the desired task name, or highlight the desired name if opening an existing task, and click on **OK**. A graphic window and an extended menu-bar now appear.

3. Pull down the **Task** menu again and click on **Units**. The Units dialogue appears.

4. Select the units you want to use in the calibration setup windows and when entering the concentration values. The monitor measures raw data, so these units do not affect the display data. Click on **OK**.

5. Pull down the **Sequence** menu. Click on **Settings**. The Calibration Sequence Settings dialogue is displayed, Fig.14.8.

Calibration index card

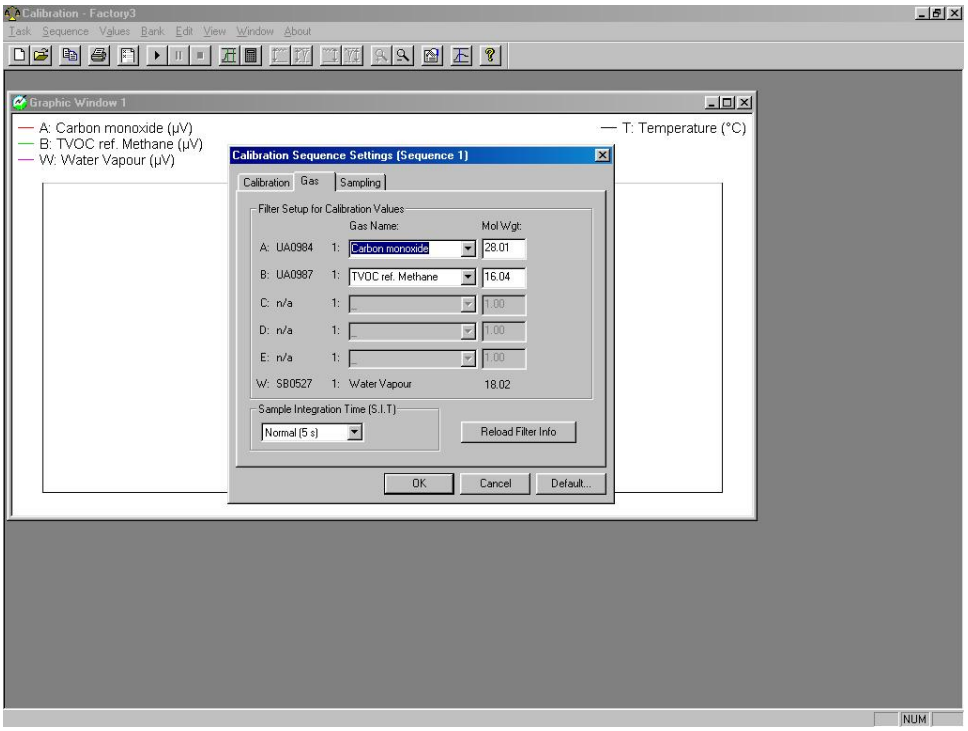
6. Click on the Calibration index-card, if it is not already at the front.

7. Click on the radio-button to select the desired calibration type. The individual sections named below provide full details.
   - Zero point – see section 14.7
   - Humidity – see section 14.8
   - Gas span – see section 14.11

Gas index card

8. Click on the Gas index-card, see Fig.14.9.

Fig.14.9 Gas Settings dialogue



9. If you have not uploaded the calibration, filter, gas names and molecular weight information already, then do it now. Click on the **Reload Filter Info**. soft-key. This takes several minutes, so wait until it has finished before continuing. If you are performing a span calibration, follow the steps given in section 14.11.1. For zero-point and humidity calibrations follow the steps here.

10. Click in the Sample Integration Time field, and select the desired time.
Note: the S.I.T. value should be set to the same as those used for monitoring.

Sampling index card

11. Click on the Sampling index card.

12. Select the desired Flushing Type. The procedure to do this is the same as that used when monitoring, see section 7.2.
Note: the Flushing type and values should be set to the same as those used when monitoring.

13. When all the settings are correct, click on **OK**.

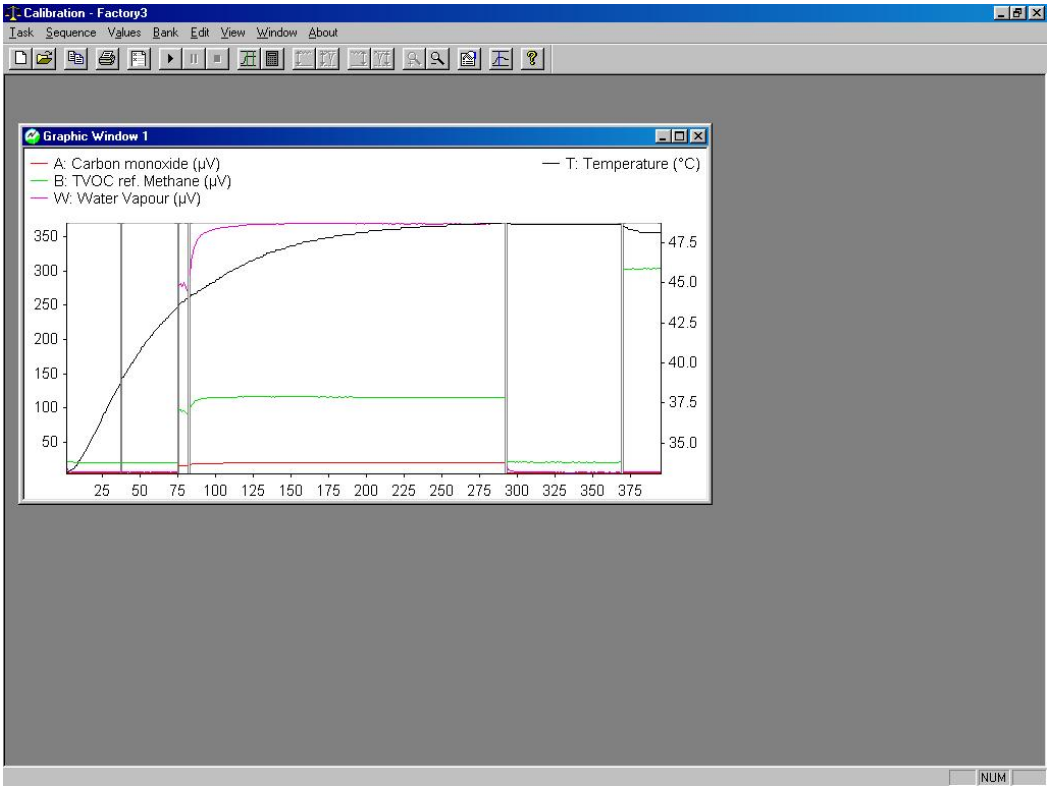
Starting a Calibration

1.
   a. Connect the free-end of the Teflon tubing mentioned in section 14.4 to the pressure valve on a cylinder of calibration gas.
   b. Gently open the pressure-valve on the gas cylinder.

2. Pull down the **Sequence** menu and click on **Start**.

The monitor will now begin to measure the raw data. All the gases have the same units - µV or mV. Fig.14.10 illustrates how measurement data is displayed.

Fig.14.10 Raw calibration data displayed on screen



Stop the calibration when you have enough raw measurement data.

Note: if you are performing a two-point span calibration, or, you want more than one calibration type, then you can at this point stop the calibration, change the Calibration Sequence Settings and calibration gas, restart the measurement and collect the new raw data for the next span concentration or optical filter. This enables you to gather all the measurement data and then calculate all the calibration factors in a single operation.

Stopping a Calibration Task

Pull down the **Sequence** menu and click on **Stop**.

14.5.2 Calculating Calibration Factors

Once you have measured enough raw data, you are able to calculate the calibration factors. With the raw measurement data displayed on screen:

1. Open the Cursor Values dialogue. Use of the cursors is described in section 8.4.

2. Use two cursors and the statistical data are displayed in the Cursor Values dialogue to locate a suitable range of data.

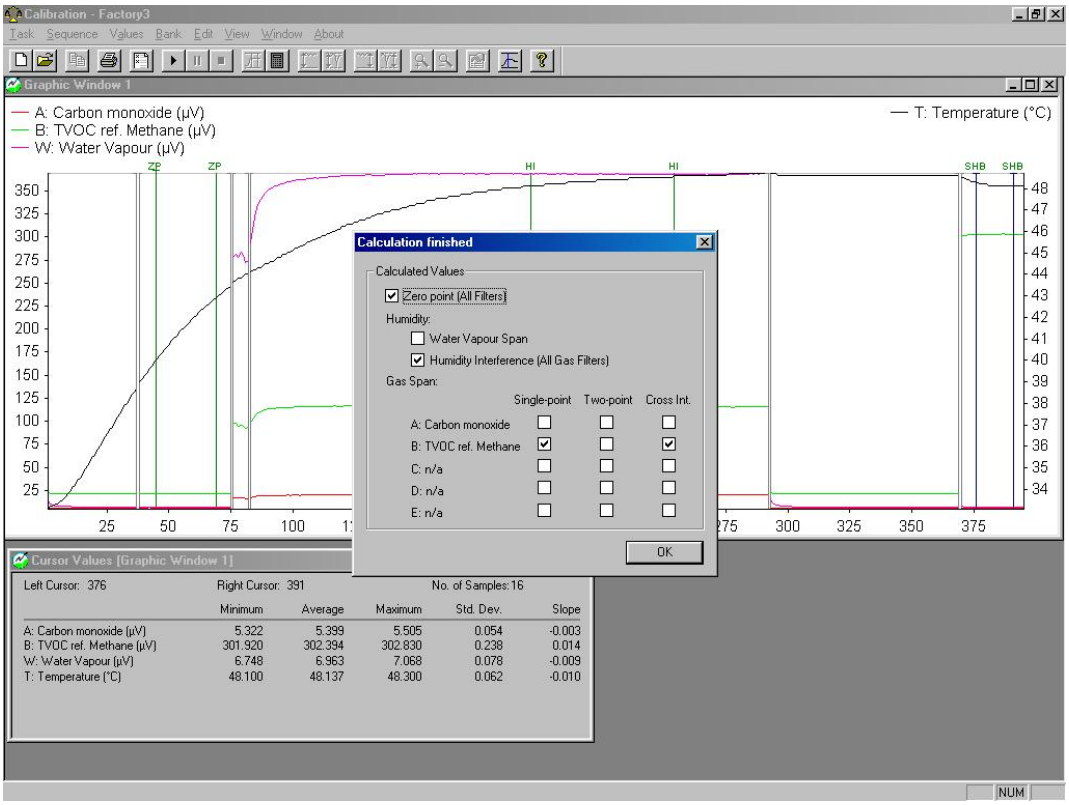
3. When you have the desired region between the cursors, pull down the **Sequence** menu and click on **Mark Interval**.
   Note: the marked interval must be the same type in the whole interval.
   The two cursors are replaced by a pair of green lines. These lines have markings at the end of them, which show the type of calibration data lying between the lines. The markings are:

   ZP: shows a zero point calibration
   HS: shows a humidity span calibration
   HI: shows a humidity interference calibration
   HIS: shows a humidity interference and a humidity span calibration
   SHA: shows a Single point or Two point (High conc.) span calibration (filter A)
   SLA: shows a Two point (Low conc.) span calibration (filter A)

4. Pull down the value menu and click on **calculate**

5. When the calculation(s) is complete a Calculation Finished dialogue is displayed.
   See Fig.14.11.

Fig.14.11 Calculation Finished dialogue



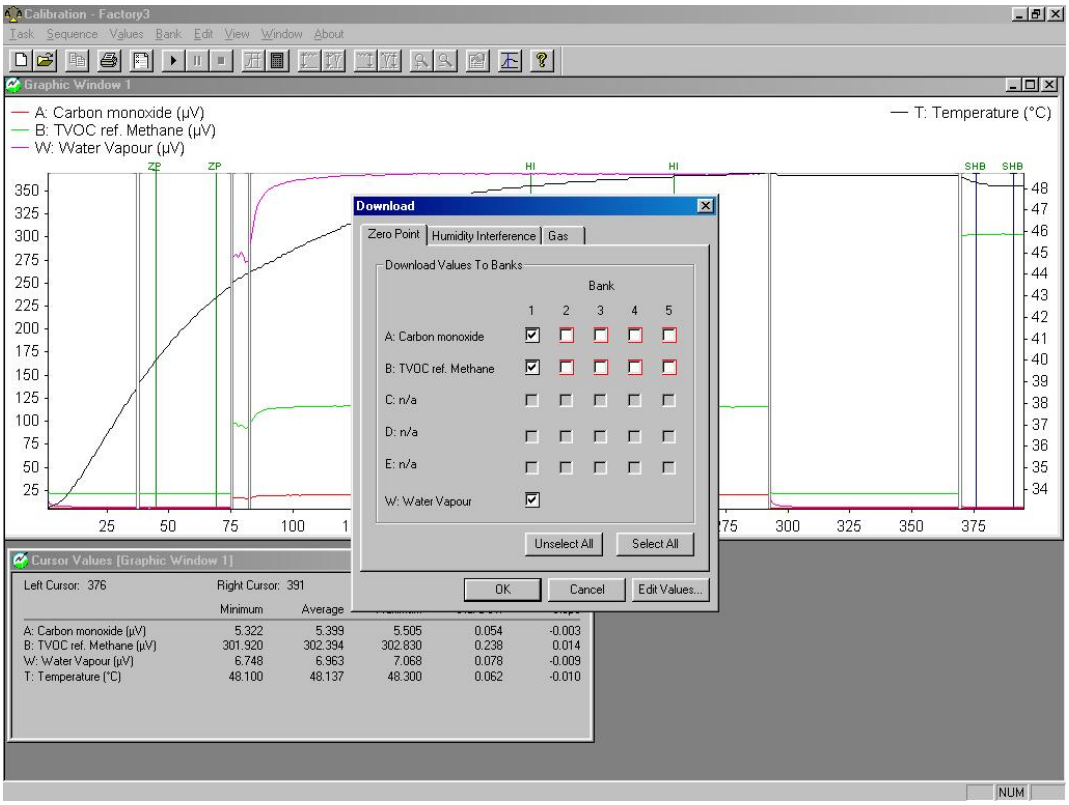
This dialogue informs you which calibration factors have been calculated by placing a tick in the check box. The number of check boxes ticked depends on the number of curves marked, and not the number of gases measured.

14.5.3 Downloading the Calculated Values

When you are finished measuring the raw data and have calculated the calibration factors, then you are ready to download the calculated values to the Monitor.

NOTE: calibration factors calculated for a specific filter *cannot* be downloaded to filter banks of another filter.

Fig.14.12 Download dialogue



The Download dialogue, see Fig.14.12, is divided by index cards into three calibration types; Zero point, Humidity interference and Gas (span calibration). The names of the calibrated gases for the different filters are listed, and opposite each filter position are 5 check boxes. These boxes represent the 5 filter banks for each optical filter. The check boxes provide 4 types of information:

- The white boxes represent filter banks containing no calibration factors – you can freely enter calibration factors here without losing any existing information.

- The white boxes with a red shadow already contain calibration factors – you can download the new factors to these filter banks, but the existing information will be lost.

- The ticked check boxes with a black shadow are the computers suggestion as to where the new calibration factors should be downloaded – it is normally these positions you would select when performing a recalibration of the monitor. However, you are free to remove the tick from the check box and place it elsewhere, or place more than one tick for a filter. Several ticks enables calibration factors to be downloaded to several banks for the same filter.

- The grey boxes – these filter banks are not available – therefore no calibration factors can be downloaded here.

When a check box is ticked, then a calibration factor will be downloaded to the corresponding filter bank.
The **Select All** soft-key enables you to tick all the check boxes on the displayed index card. This is useful for zero point and humidity interference calibrations, where calibration factors are commonly required for all the filters.

To download the calculated values:

1. Pull down the **Values** menu. Click on **Download** and the Download dialogue is displayed, see Fig.14.12.

2. Depending on the calibrations performed, select the correct index card.

3. Set ticks in the preferred check boxes.

4. Repeat steps 2 and 3 until all the desired check boxes are ticked.

Special Function – Edit Values

Warning! This option should only be used by experienced users. Editing the calibration values here can result in the monitor providing incorrect results.

a. If you want to edit the calibration values manually, click on the **Edit Values** soft-key.

b. When you are sure that the results are correct and the correct values and filters have been selected, click on **OK**. This returns you to the Download dialogue.

5. When you are sure you have selected the correct filter bank numbers, click on **OK**. The calibration factors are now downloaded to the monitor.

14.5.4 Downloading Existing Calibration Factors

If you have made a back-up of the calibration factors present in the monitor, using the Upload Banks from Gas Monitor option, it is possible to reload them again without performing the calibrations described above. This is possible using the “Download Banks to Gas Monitor” option. You can download the values for all the filters, or you can select single filter values to be downloaded. This is done as follows:

1. Pull down the **Bank** menu, Click on **Download Banks to Gas Monitor** and the Download Banks to Monitor dialogue appears.

2. Click on the desired radio-button: All Banks or Single.
   If you select Single, highlight the correct filter and filter bank.

3. Click on **OK**.

14.6 General Settings – Stand-alone Use

Before a practical calibration task can be started, the monitor has to be informed about the kind of calibration task you wish it to perform. This is done using the push-buttons on the front panel of the Monitor.

The **Calibration Task** Set-Up Tree is illustrated in Fig.14.13. It should be used to help you follow the path through the different levels of the calibration set-up. The calibration tasks are set-up while operating in **Measure** mode.

Notice the following:

1. Before starting to set-up a calibration task you must make sure that you choose the correct FILTER BANK NO. to store the calibration factors which will be calculated during calibration (see section 14.3.3).

2. If you answer “YES” to **PERFORM ZERO-POINT CALIBRATION ?**, then **ALL** the installed optical filters (“A” to “E”) will be zero-point calibrated, and the **concentration offset factor** for each filter will be stored in the filter bank no. which is **active** for that filter during the practical calibration task.

3. If you answer “YES” to **PERFORM HUM. INTERFERENCE CALIBRATION ?**, then **ALL** the installed optical filters (“A” to “E”) will be calibrated for humidity interference, and the **humidity gain factor** for each filter will be stored in the filter bank no. which is active for that filter during the practical calibration task.

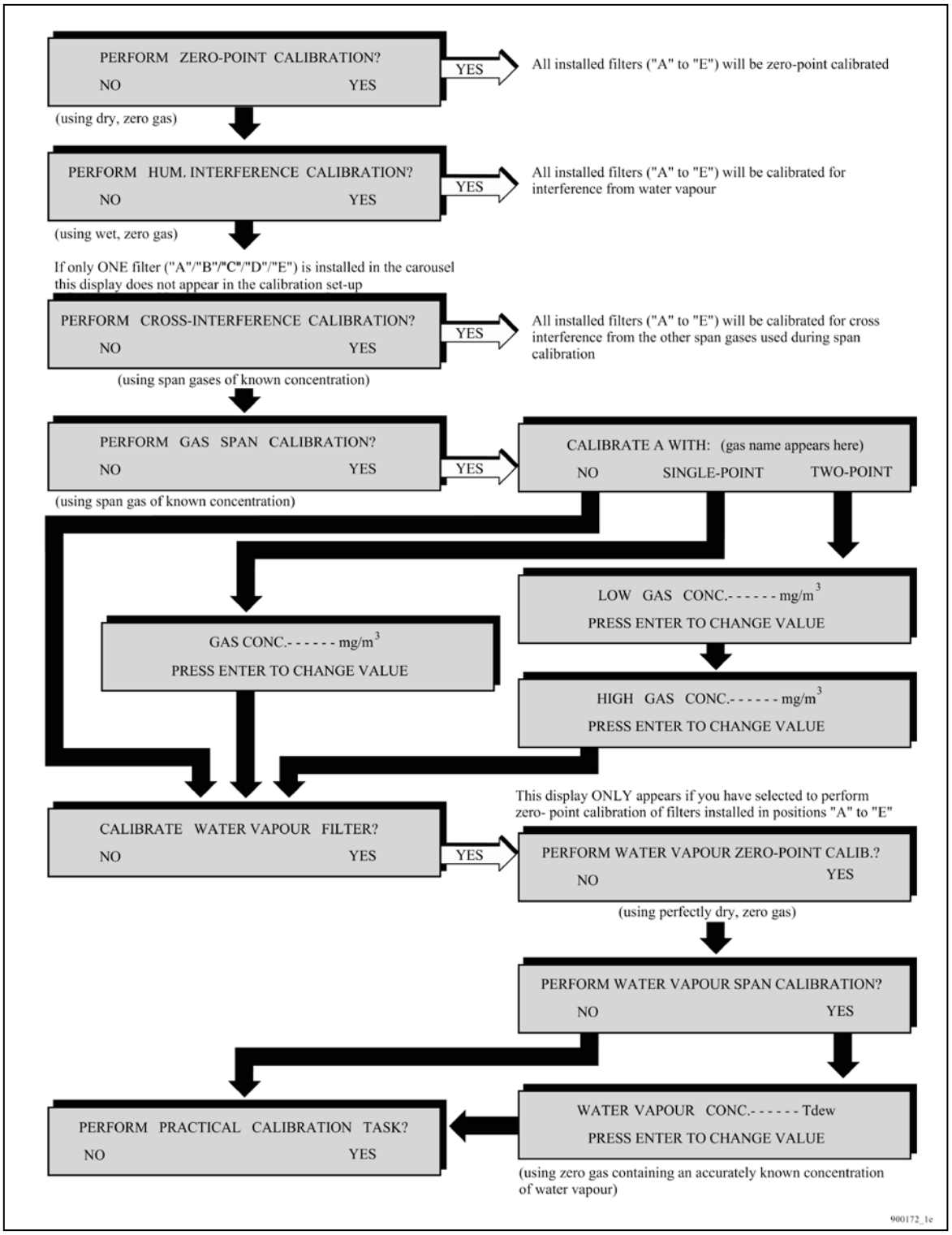
4. If you answer “YES” to **PERFORM CROSS INTERFERENCE CALIBRATION ?**, then, during the span calibration of each filter, when each known concentration of span gas is attached to the Monitor’s air inlet, the signal in the cell is measured using **ALL** of the installed optical filters. The factors which describe each **gas’s interference measured** on the other installed filters are stored in the **active** filter bank of the filter installed to measure this gas.

5. If you answer “YES” to **PERFORM GAS SPAN CALIBRATION ?**, then you can choose (1) which of the installed filters you wish to span calibrate; and (2) whether this calibration should be a single-point or a two-point span calibration. The **concentration conversion factor** calculated during span calibration for a particular gas using a particular filter), is stored in the filter bank no. which is **active** during the calibration procedure.

14.6.1 Retaining Existing Calibration Factors

When zero-point, humidity-interference and cross-interference calibrations are performed, all the installed filters are calibrated. In some case, you may wish to keep the calibration factors already present in your monitor. If this is the case, use the following instructions.

Fig.14.13 Schematic diagram showing the calibration task Set-Up Tree (general)


PERFORM ZERO-POINT CALIBRATION?
NO YES
YES
All installed filters ("A" to "E") will be zero-point calibrated
(using dry, zero gas)
PERFORM HUM. INTERFERENCE CALIBRATION?
NO YES
YES
All installed filters ("A" to "E") will be calibrated for interference from water vapour
(using wet, zero gas)
If only ONE filter ("A"/"B"/"C"/"D"/"E") is installed in the carousel this display does not appear in the calibration set-up
PERFORM CROSS-INTERFERENCE CALIBRATION?
NO YES
YES
All installed filters ("A" to "E") will be calibrated for cross interference from the other span gases used during span calibration
(using span gases of known concentration)
PERFORM GAS SPAN CALIBRATION?
NO YES
YES
CALIBRATE A WITH: (gas name appears here)
NO SINGLE-POINT TWO-POINT
(using span gas of known concentration)
LOW GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
HIGH GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
This display ONLY appears if you have selected to perform zero- point calibration of filters installed in positions "A" to "E"
CALIBRATE WATER VAPOUR FILTER?
NO YES
YES
PERFORM WATER VAPOUR ZERO-POINT CALIB.?
NO YES
(using perfectly dry, zero gas)
PERFORM WATER VAPOUR SPAN CALIBRATION?
NO YES
PERFORM PRACTICAL CALIBRATION TASK?
NO YES
WATER VAPOUR CONC.- - - - - - Tdew
PRESS ENTER TO CHANGE VALUE
(using zero gas containing an accurately known concentration of water vapour)
900172_1e

Before setting-up a calibration task, make sure that the filter banks you make **active** for the filters which have already been calibrated only contain **calibration factors** which need to be up-dated. In this way you can prevent your original **calibration factors** being overwritten by the new ones. To illustrate this, imagine that filters

"A", "B", "C" and "D" are installed in your Monitor and have been calibrated. Suppose **the calibration data block** of your Monitor contains the information shown in Fig.14.14 (notice no filter is installed in position E). Suppose you now install an optical filter in position "E". This filter has to be fully calibrated. Before performing a zero-point and humidity-interference task one of the following filter banks must be made **active**:

- Filter bank no. 3, 4 or 5 for filter "A";
- Filter bank no. 2, 3 or 5 for filter "B";
- Filter bank no. 2, 3 or 4 for filter "C";
- Filter bank no. 2, 3, 4 or 5 for filter "D".

Suppose you make filter bank no. 3 **active** for all the above filters and filter bank no. 1 **active** for filter "E". Then, after a zero-point calibration the **calibration data block** would contain the information shown in Fig.14.15. None of the original calibration data has been overwritten by the newly-calculated calibration factors.

Fig.14.14 Illustration of the calibration data stored in the filter banks of filters "A" to "D" before a zero-point calibration task

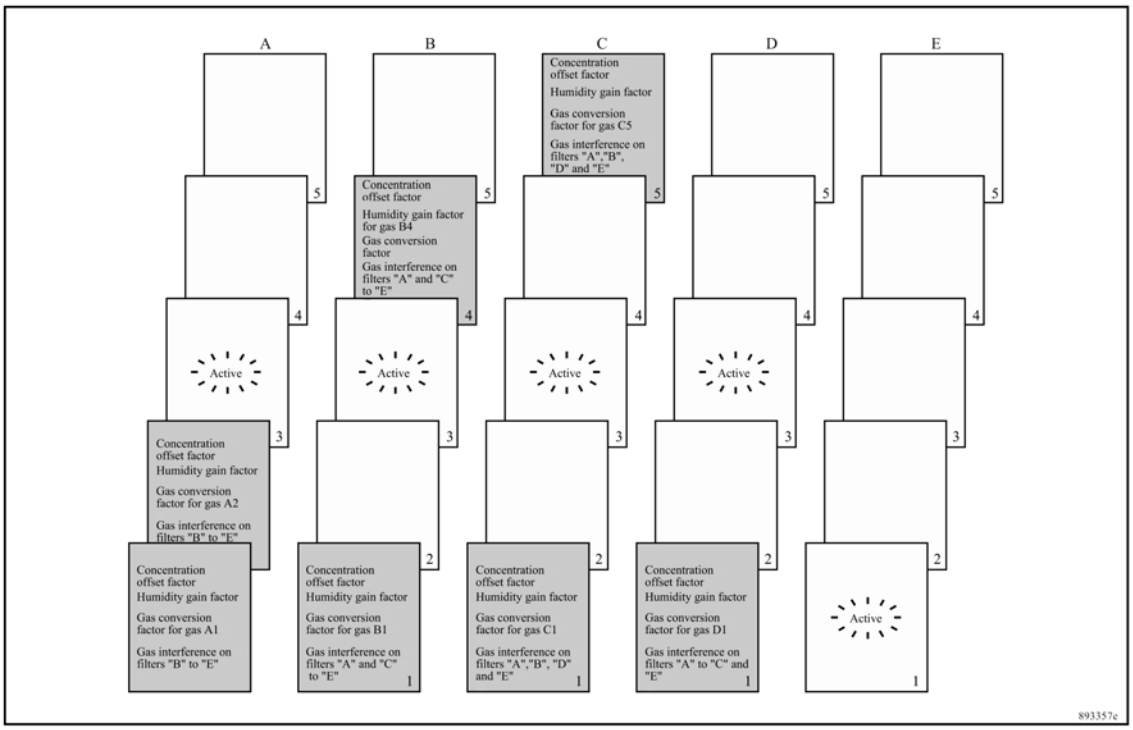
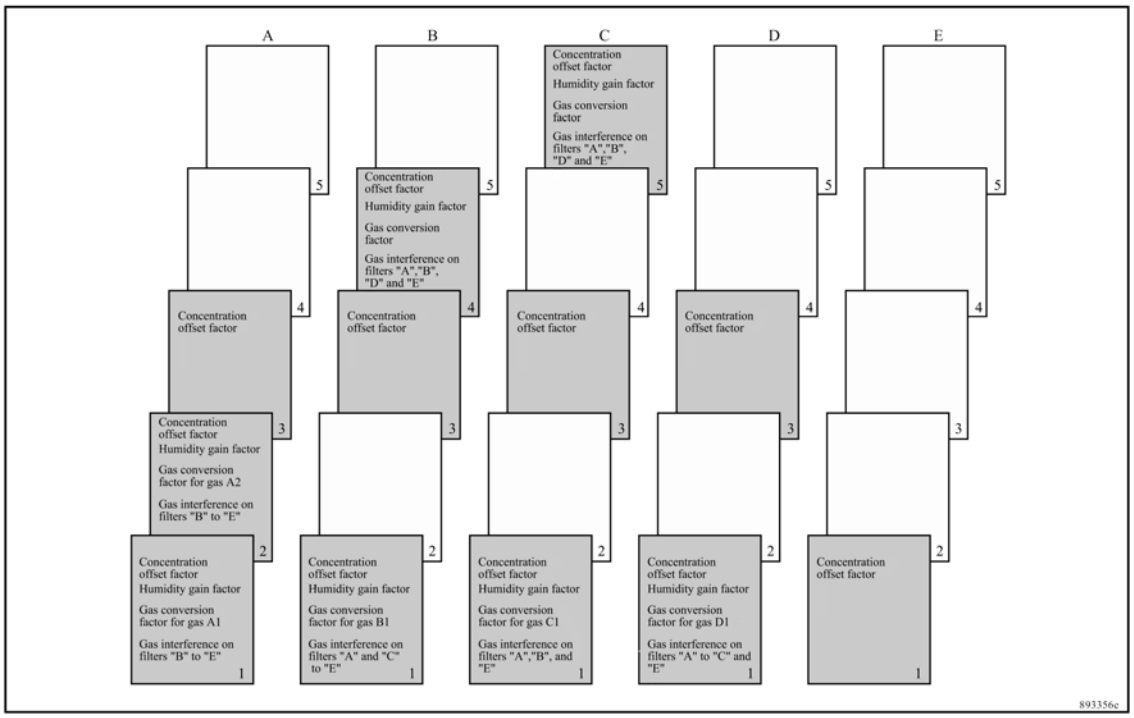

A
B
C
D
E
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas C5
Gas interference on filters "A","B", "D" and "E"
Concentration offset factor
Humidity gain factor for gas B4
Gas conversion factor
Gas interference on filters "A" and "C" to "E"
Active
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas A2
Gas interference on filters "B" to "E"
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas A1
Gas interference on filters "B" to "E"
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas B1
Gas interference on filters "A" and "C" to "E"
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas C1
Gas interference on filters "A","B", "D" and "E"
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas D1
Gas interference on filters "A" to "C" and "E"
893357e

Fig.14.15 Illustration of the calibration data stored in the filter banks of filters "A" to "E" after a zero-point calibration task


A
B
C
D
E
Concentration offset factor
Humidity gain factor
Gas conversion factor
Gas interference on filters "A","B", "D" and "E"
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas A2
Gas interference on filters "B" to "E"
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas A1
Gas interference on filters "B" to "E"
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas B1
Gas interference on filters "A" and "C" to "E"
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas C1
Gas interference on filters "A","B", and "E"
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas D1
Gas interference on filters "A" to "C" and "E"
Concentration offset factor
893356c

14.7 Zero-point Calibration

To calculate the **concentration offset factor** for a filter (during a zero-point calibration) it is necessary to have a **humidity gain factor** for the filter, and vice versa. If a **humidity gain factor** is not stored in each of the filter banks, which are **active** during a **zero-point** calibration, then it is necessary to perform a **combined** zero-point and humidity-interference calibration task. The set-up of this combined task is discussed in section 14.13.

As mentioned in the previous sections, the zero-point calibration task is not selective. This means that you cannot choose zero-point calibration of a **single** filter in the carousel (for example, when a new optical filter has been installed). When you perform a zero-point calibration then **all** the installed filters will be zero-point calibrated.

If it is only a newly-installed optical filter which needs to be calibrated, then the same procedure used for an individual filter must be used, see section 14.6.1. In this way you can protect your original **concentration offset factors**.

14.7.1 Setting a Zero-point Calibration –7304 PC Use

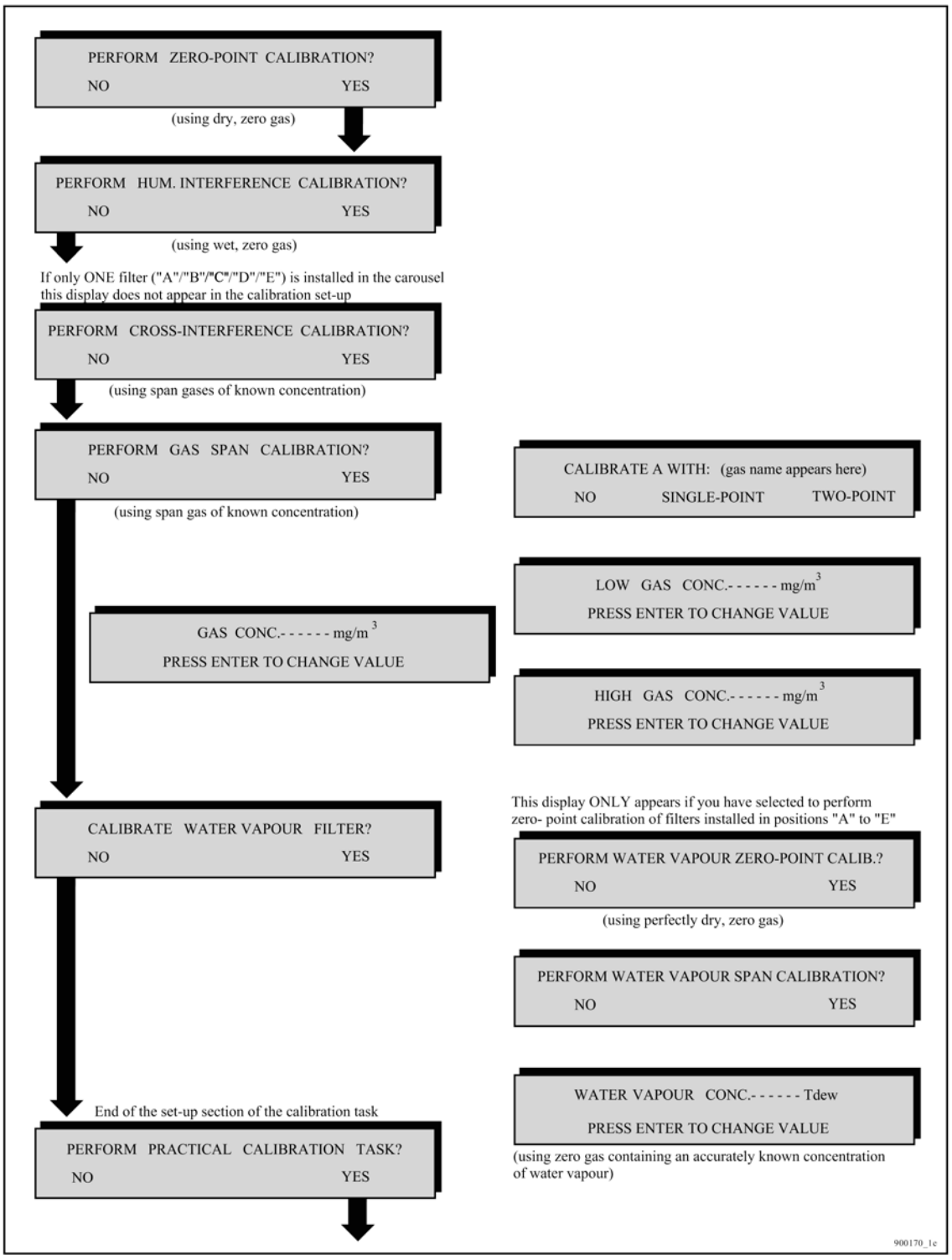
Note: the gas supply required during a zero-point calibration is a pure gas that does not absorb infra-red light, e.g. pure nitrogen.

Note: if you want to be able to use this zero-point calibration in connection with a span calibration of the water filter, then is **vitally** important that the gas is perfectly dry.
The general equipment necessary to perform a calibration task is described in section 14.4. Follow the procedure from step 1 to step 3 inclusive and then continue as follows:

Use the instructions in section 14.5.1. Click on the radio-button next to Zero Point Calibration on the “Calibration” index card. Now continue from step 8. in section 14.5.1.

14.7.2 Setting-up a Zero-point Calibration – Stand-alone Use

Fig.14.16 Schematic diagram showing how to set-up a zero-point calibration task (follow the arrows)


PERFORM ZERO-POINT CALIBRATION?
NO YES
(using dry, zero gas)
PERFORM HUM. INTERFERENCE CALIBRATION?
NO YES
(using wet, zero gas)
If only ONE filter ("A"/"B"/"C"/"D"/"E") is installed in the carousel this display does not appear in the calibration set-up
PERFORM CROSS-INTERFERENCE CALIBRATION?
NO YES
(using span gases of known concentration)
PERFORM GAS SPAN CALIBRATION?
NO YES
(using span gas of known concentration)
CALIBRATE A WITH: (gas name appears here)
NO SINGLE-POINT TWO-POINT
LOW GAS CONC.- - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
GAS CONC.- - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
HIGH GAS CONC.- - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
This display ONLY appears if you have selected to perform zero- point calibration of filters installed in positions "A" to "E"
CALIBRATE WATER VAPOUR FILTER?
NO YES
PERFORM WATER VAPOUR ZERO-POINT CALIB.?
NO YES
(using perfectly dry, zero gas)
PERFORM WATER VAPOUR SPAN CALIBRATION?
NO YES
WATER VAPOUR CONC.- - - - - Tdew
PRESS ENTER TO CHANGE VALUE
(using zero gas containing an accurately known concentration of water vapour)
End of the set-up section of the calibration task
PERFORM PRACTICAL CALIBRATION TASK?
NO YES
900170_1e

Use the Set-up Tree in Fig.14.16 to help you navigate through the different screen displays.

Note: before starting a calibration, S.I.T (see section 14.3.3) and Flushing Type (see section 7.2) need to be set so that they are the same as those values used when monitoring.

1. For each installed filter, enter the no. of the filter bank where you wish the Monitor to store the **concentration offset factors** which will be calculated during the zero-point calibration task.

2. Press **MEASURE** **S3** **S3** **S1**. The following text will be displayed:

PERFORM ZERO-POINT CALIBRATION ?
NO YES

3. Follow the set-up of a zero-point calibration task by following the black arrows in the schematic diagram shown in Fig.14.16.

The following text will appear on the display:

ZERO-POINT CALIB. CONNECT CLEAN, DRY AIR AND PRESS ENTER WHEN READY

14.7.3 Performing a Zero-point Calibration – Stand-alone Use

The general equipment necessary to perform a calibration task is described in section 14.4. Follow the procedure from step 1 to step 3 inclusive and then continue as follows:

1.
   a. Connect the free-end of the teflon tubing mentioned in step 3 to the pressure valve on a cylinder of zero gas (e.g. pure nitrogen).

   b. Gently open the pressure-valve on the gas cylinder.

   c. Press ↵.

   d. Use the pressure-valve on the gas cylinder to regulate the flow of gas so that when the Monitor's pump is running there is a positive flow of gas **out** of the flow meter. This will ensure that the zero gas is not contaminated by atmospheric air.

   The following text appears on the screen:

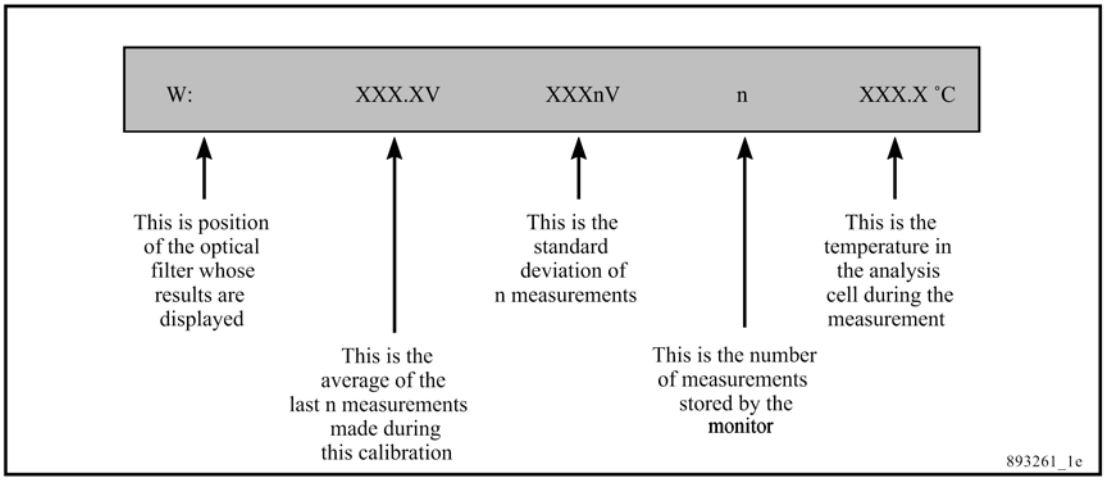
RESULTS NOT YET AVAILABLE
PLEASE WAIT

Once the first measurement result is available the screen text illustrated above is replaced by a screen displaying the measurement results – for example the following:

W: μ : 11.3μV σ --- V 1 38.6°C
PRESS ENTER WHEN RESULTS ARE STABLE

As soon as measurement results are available they not only appear on the display (see Fig.14.17) but are automatically printed out on the printer, if the Monitor has been set up to print a data log, see section 12.5. Remember to turn off the data log when the calibration is complete.

Fig.14.17 Example of data displayed during a calibration (the text below the display describes the displayed data)


W: XXX.XV XXXnV n XXX.X °C
This is position of the optical filter whose results are displayed
This is the average of the last n measurements made during this calibration
This is the standard deviation of n measurements
This is the number of measurements stored by the monitor
This is the temperature in the analysis cell during the measurement
893261_1e

Each time a sample of gas is drawn into the analysis cell the signal is measured using **all** the installed optical filters and the water-vapour filter ("W") but, due to lack of space on the **display**, the Monitor only displays the signal measured using the water-vapour filter. You cannot scroll through the measurements. The data-log print-out, however, shows the signal measured using **all** installed filters as well as the water-vapour filter.

A maximum of 6 measurements are stored in the Monitor during any calibration. The number (n) indicates how many measurements are stored. When 7 measurements have been performed the number (n) will show the number 6 because the very first measurement is overwritten by the 7th measurement so that only 6 measurements are still stored. When 8 measurements

have been completed the number (n) will also show 6 because the results of the first and second measurements have been overwritten by the 7th and 8th measurement results …and so on.

2. Let the Monitor continue measuring the zero gas until the temperature in the cell is stable. Look at the print-out of the average and standard deviation measurements for (1) the water-vapour and (2) all the other filters. When all these values have stabilised calibration measurements, do not need to continue. Continue to the next step.

3. Press ↵.
   This causes the following text to appear on the screen:

A: μ : 5.28 μV σ : 94 nV 6 38.4°C
PRESS ENTER WHEN RESULTS ARE STABLE

   These results have been shown on the data-log print-out. If they have stabilised continue to the next Step.

4. Repeat step 3 until the signals measured with all the filters have been displayed, stabilised and been “accepted”.

   The text **CALCULATION. PLEASE WAIT** appears on the screen.
   The Monitor only uses the last six measurement results when calculating any calibration factor. The **concentration offset factors** calculated during **zero-point calibration** of the filters, are related to the cell noise measured in the cell when each of the filters is being used.
   If any calibration data is uncertain or unacceptable an error message (marked by an asterisk) will appear on the screen after the calibration factors have been calculated. Whenever an asterisk is shown on the screen further information about the condition of the Monitor can be obtained by pressing **INFO**.
   Chapter 16 lists all the error messages connected with uncertain calibration results and gives an explanation of their significance so that the user can ascertain what action to take if such messages are displayed after calibration.

14.8 Humidity Calibrations – 7304 PC Use

The water-vapour filter has two different functions. Its most important function is to enable any measured signal to be compensated for water-vapour interference. Its other function is to measure the absolute concentration of water-vapour in air samples. If you only wish to use the water-vapour filter to compensate for water-vapour interference, then it only has to be **zero-point calibrated**. If you wish to use it to measure the absolute

concentration of water vapour in air samples then it has to be **zero-point calibrated** and **span calibrated**.

When the Humidity Calibration radio-button is selected two check boxes appear in the *Calibration Parameters* field:

Perform Water Vapour Span Calibration: this is a span calibration performed specifically on the water vapour filter installed in the filter carousel, (position W). When you tick this check box, a clean, wet gas with a known water concentration must be used. This concentration must be entered in the *Water Concentration* field.

Humidity Interference: this calibration is performed on all the filters. However, like the zero point calibration, you are able to select which filters receive the **humidity gain factors** when you download them. Like the span calibration of the water filter, a constant concentration of wet gas is required here. However, you do not need to know the concentration of the water vapour in this case.

These calibrations can be performed individually or both together, which ever suits your needs.

Setting-up and performing a Humidity Calibration

Note: the gas supply required during a humidity calibration is a clean, wet air supply, as described in section 14.4.1.

The general equipment necessary to perform a calibration task is described in section 14.4. Follow the procedure from step 1 to step 3 inclusive and then continue as follows:

1. Follow the instructions in section 14.5.1 up to step 7.

2. Click on the radio-button next to Humidity Calibration on the “Calibration” index card. Select one or both of the calibration tasks.
   If you select a Water Vapour Span Calibration, remember to enter the correct water concentration value.

Now continue from step 8. in section 14.5.1.

14.9 Humidity-interference Calibrations – Stand-alone Use

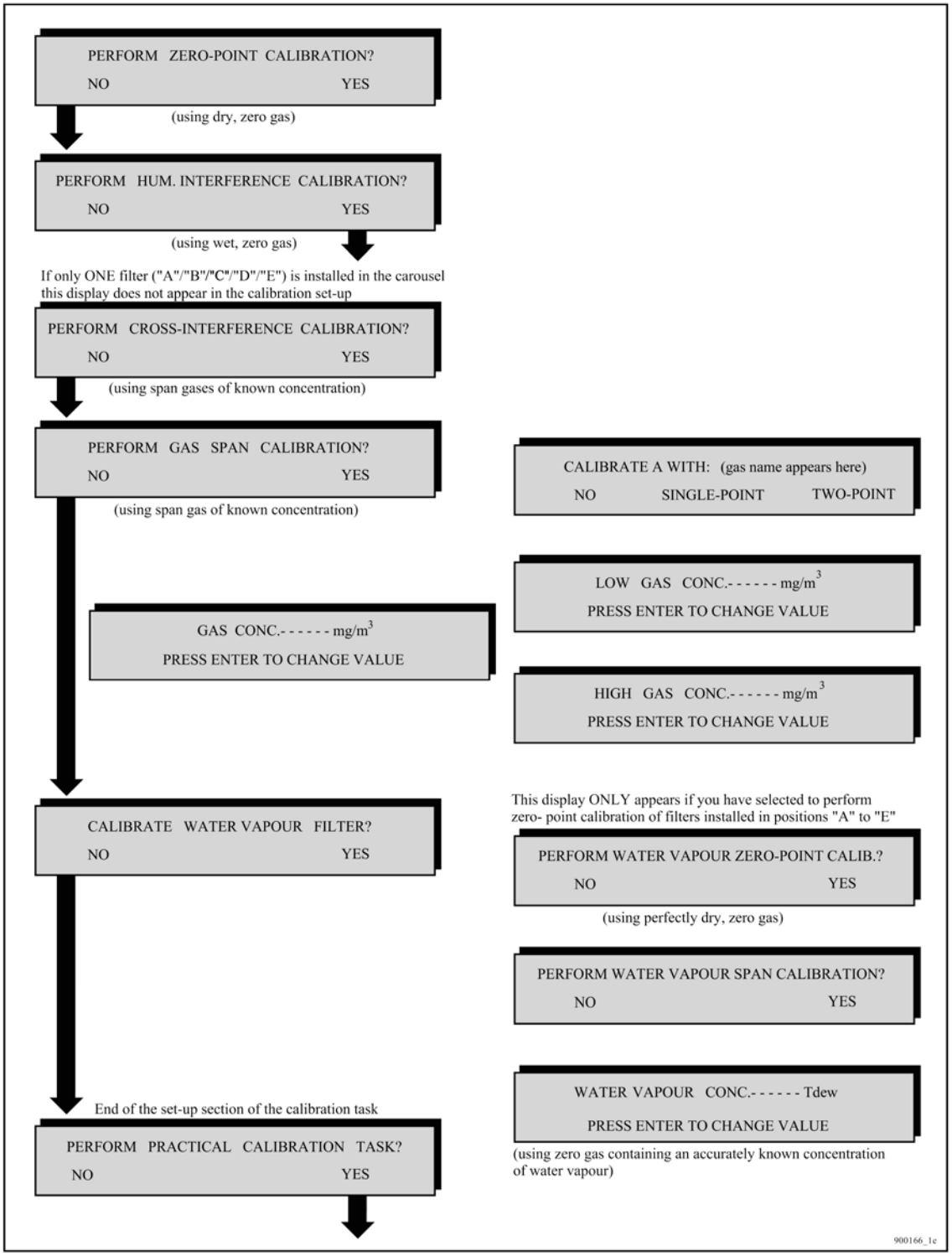
As previously mentioned, the humidity-interference calibration task is not selective. This means that you cannot choose humidity-

interference calibration of a **single** filter in the carousel (for example, when a new optical filter has been installed). When you perform a humidity-interference calibration then **all** the installed filters will be humidity-interference calibrated.

If it is only a newly-installed optical filter which needs to be humidity-interference calibrated, then the same procedure used for a zero-point calibration of an individual filter must be used, see section 14.6.1. In this way you can protect your original **humidity gain factors**.

14.9.1 Setting-up a Humidity-interference Calibration Task

Fig.14.18 Schematic diagram showing how to set-up a humidity-interference calibration task (follow the arrows)


PERFORM ZERO-POINT CALIBRATION?
NO YES
(using dry, zero gas)
PERFORM HUM. INTERFERENCE CALIBRATION?
NO YES
(using wet, zero gas)
If only ONE filter ("A"/"B"/"C"/"D"/"E") is installed in the carousel this display does not appear in the calibration set-up
PERFORM CROSS-INTERFERENCE CALIBRATION?
NO YES
(using span gases of known concentration)
PERFORM GAS SPAN CALIBRATION?
NO YES
(using span gas of known concentration)
CALIBRATE A WITH: (gas name appears here)
NO SINGLE-POINT TWO-POINT
LOW GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
HIGH GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
CALIBRATE WATER VAPOUR FILTER?
NO YES
This display ONLY appears if you have selected to perform zero- point calibration of filters installed in positions "A" to "E"
PERFORM WATER VAPOUR ZERO-POINT CALIB.?
NO YES
(using perfectly dry, zero gas)
PERFORM WATER VAPOUR SPAN CALIBRATION?
NO YES
WATER VAPOUR CONC.- - - - - - Tdew
PRESS ENTER TO CHANGE VALUE
(using zero gas containing an accurately known concentration of water vapour)
End of the set-up section of the calibration task
PERFORM PRACTICAL CALIBRATION TASK?
NO YES
900166_1e

To calculate the **humidity gain factor** for a filter (during a humidity-interference calibration) it is necessary to have a

concentration offset factor for the filter, and vice versa. **Note: If a concentration offset factor is not stored in each of the filter banks which are active during a zero-point calibration, then it is necessary to perform a combined zero-point and humidity-interference calibration ta**sk. The set-up of this combined task is discussed in section 14.13.

If you only wish to set-up a humidity-interference calibration task the procedure is as follows:

1. For each installed filter, enter the no. of the filter bank where you wish the Monitor to store the **humidity gain factors** which will be calculated during the humidity-interference calibration task.

2. Press **MEASURE** **S3** **S3** **S1** then the following text will be displayed:

PERFORM ZERO-POINT CALIBRATION ?
NO YES

3. Follow the set-up of a humidity-interference calibration task by following the black arrows in the schematic diagram shown in Fig.14.18.
   The following text will appear on the display:

HUM. INTERFERENCE. CONNECT CLEAN, WET AIR AND PRESS ENTER WHEN READY

14.9.2 Performing a Humidity-interference Calibration

The general equipment necessary to perform a calibration task is described in section 14.4 and illustrated in Fig.14.5.
The gas supply required during a humidity-interference calibration is a supply of clean air containing a constant concentration of water vapour.

1. Follow the procedure explained in section 14.4 from steps 1 to 3 inclusive and the continue as follows:

2.
   a. Connect the outer end of the extra empty flask's outlet tube "B" to the Teflon tubing which is connected to attachment point 3 of the "Y"-piece (see Fig.14.7).

Caution: the inner end of the empty-flask's outlet tube "B" must NEVER be covered by water.

b. Gently open the pressure-valve on the zero-gas cylinder.

c. Press ↵.

d. Use the pressure-valve on the zero-gas cylinder to regulate the flow of gas so that when the Monitor's pump is running there is a positive flow of gas out of the flow meter. This will ensure that the wet, zero gas is not contaminated by atmospheric air.

The following text appears on the screen:

RESULTS NOT YET AVAILABLE **PLEASE WAIT**

The Monitor draws in the clean, wet air and measures the signal in the cell with the water-vapour filter as well as with **all** the other installed filters. Once the first measurement result is available the screen text illustrated above is replaced by a screen displaying signal measured using the water-vapour filter – for example the following:

W : µ : 340 µV σ :--- V 1 39.3°C **PRESS ENTER WHEN RESULTS ARE STABLE**

As soon as measurement results are available they do not only appear on the display but are automatically printed out on the printer, if the monitor is set up to print a data-log. Remember to turn off the data-log when the calibration is complete.
Each time a sample of gas is drawn into the analysis cell the signal is measured using **all** the installed optical filters and the water-vapour filter ("W") but, due to lack of space on the **display**, the Monitor first only displays the signal measured using the water-vapour filter. The data-log print-out, however, shows the signal measured using **all** installed filters as well as the water-vapour filter.

A maximum of 6 measurements are stored in the Monitor during any calibration. The number (n) indicates how many measurements are stored. When 7 measurements have been performed the number (n) will show the number 6 because the very first measurement is overwritten by the 7^{th} measurement so that only 6 measurements are still stored. When 8 measurements have been completed the number (n) will also show 6 because the results of the first and second measurements have been overwritten by the 7^{th} and 8^{th} measurement results …and so on.

3. Let the Monitor continue measuring the clean, wet air until the temperature in the cell is stable. Look at the print-out of the average and standard deviation measurements for (1) the water-vapour and (2) all the other filters. When all these values have stabilised, calibration measurements do not need to continue. Continue to the next Step.

4. Press ↵.
   This will cause the results of measurements made with all the other installed filters to be displayed, for example:

A : μ : 19.34 μV σ : 212 nV 6 39.3°C
PRESS ENTER WHEN RESULTS ARE STABLE

   These results have been printed out on the data-log printer. If they have stabilised continue to the next Step.

5. Repeat step 4 until the signals measured with all the filters have been displayed, stabilised and been “accepted”.

The text **CALCULATING PLEASE WAIT** appears on the screen.

The Monitor only uses the last six measurement results when calculating any calibration factor. The **humidity gain factors** calculated during **humidity-interference calibration** of the filters, are a measure of the sensitivity of each filter to water-vapour interference.

If any calibration data is uncertain or unacceptable an error message (marked by an asterisk) will appear on the screen after the calibration factors have been calculated. Whenever an asterisk is shown on the screen further information about the condition of the Monitor can be obtained by pressing **INFO**.

Chapter 16 lists all the error messages connected with uncertain calibration results and gives an explanation of their significance so that you can ascertain what action to take if such messages are displayed after calibration.

14.10 Cross-interference Calibrations

If any gas measured by the installed optical filters absorbs light from more than one of the installed optical filters, then it is advisable to calibrate for **cross-interference** (see section 14.1). Cross-interference calibration cannot be performed alone! It **has to be** performed together with the span calibration of each of the installed optical filters. **Cross-interference** calibration is **not** selective, that

is, if you select to perform a cross-interference calibration, then each time a gas is supplied to the Monitor during a span calibration, the signal in the cell is measured using each installed optical filter. You cannot choose which filters should be calibrated for cross-interference from a particular gas.

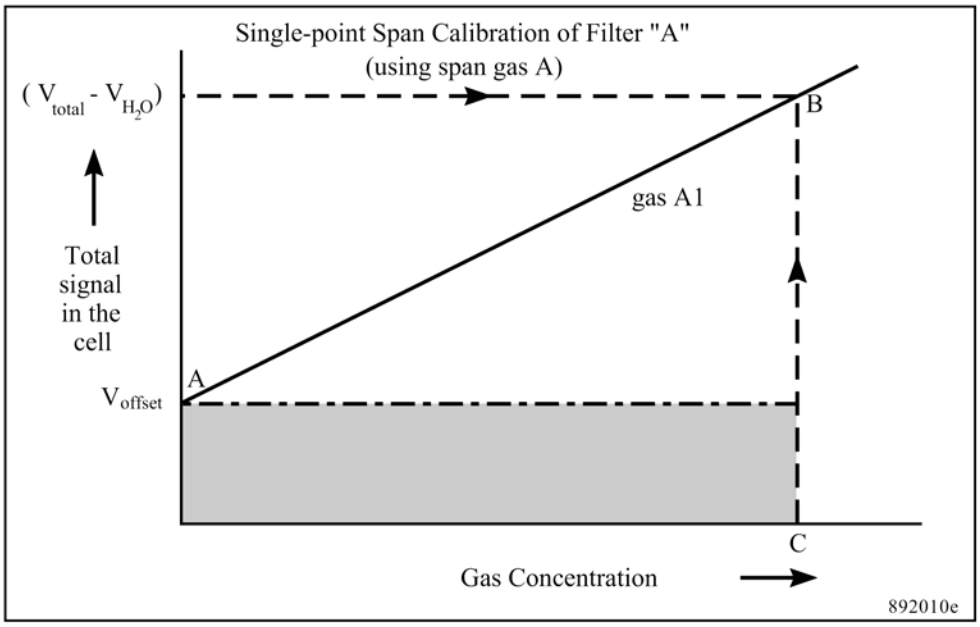
Section 14.11 includes information about how to set up a combined cross-interference and span calibration task.

14.11 Span Calibration

Before calculating the **conversion factor** for a filter (during span calibration) a **concentration offset factor** and a **humidity gain factor** must be in the filter bank which is selected for the filter during span calibration. Span calibration of a filter can therefore only be done after the filter has already been zero-point and humidity-interference calibrated.

During span calibration a supply of a particular gas (e.g. gas A1) of known concentration is attached to the air-inlet of the Monitor and the total signal in the cell is measured using the water-vapour filter and the filter which is being span calibrated (for example “A”). As filter “A” has already been calibrated for humidity interference, the total signal (V_{total}) measured with filter “A” can be compensated for any signal produced by water-vapour’s absorption of light from filter “A” (V_{H2O}) during the span calibration task. This means that your span gas does not have to be perfectly dry. As the filter has already been zero-point calibrated, the cell noise V_{offset} (when filter “A” is used) is known, and therefore the span calibration curve can be drawn (see Fig.14.19).

Fig.14.19 Curve showing a linear span-calibration curve



Choosing a filter bank

If a filter (e.g. “A”) has already been calibrated to measure a gas (e.g. A1) and you wish to calibrate with gas A1 again, then select the filter bank containing the **gas conversion factor** for gas A1. Online users can do this when downloading the calibration factors. Stand-alone users should do this before setting-up and performing the span calibration task. The **gas conversion factor** calculated during the span calibration will then just overwrite the **gas conversion factor** calculated during the previous span calibration of the filter with this gas.

If you wish to span calibrate a filter to measure more than one gas, then select a new filter bank each time you span calibrate with a different gas. In this way **the conversion factor** for each gas is stored in separate filter banks (for stand-alone use see Fig.14.14).

The **gas conversion factor** stored in the selected filter bank during a span calibration task will be overwritten by the new **gas conversion factor** calculated during the span calibration of the filter.

Gas to be Used During Span Calibration

The gas you need to use during span calibration must be the gas you wish to measure with the filter.

Type of Span Calibration – Single-point or Two-point?

Fig.14.20a Graph showing a non- linear span-calibration curve which can be plotted using the signals measured during a two-point span calibration task

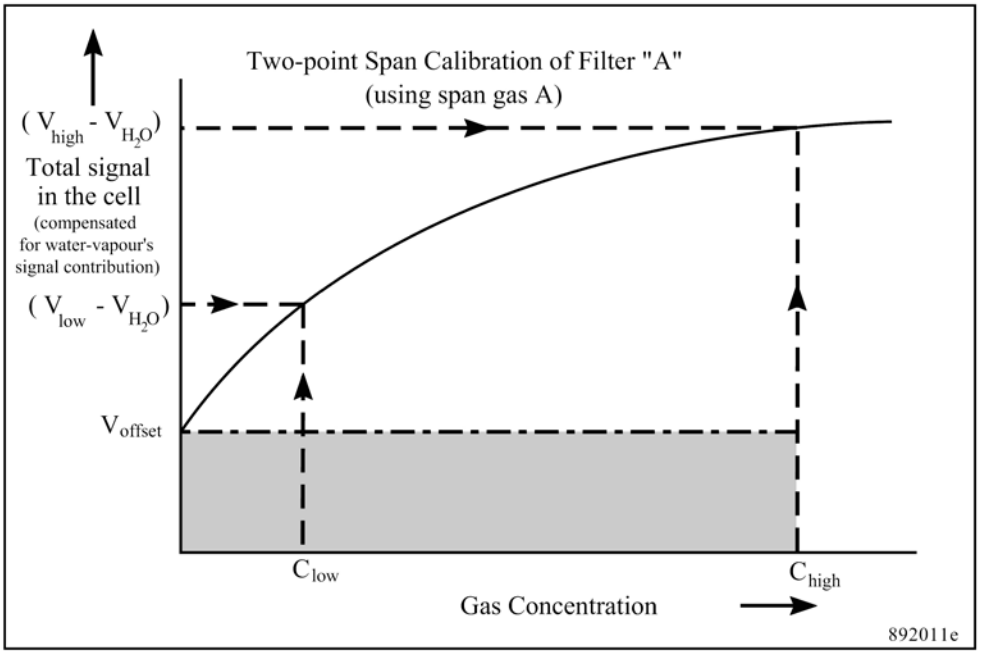
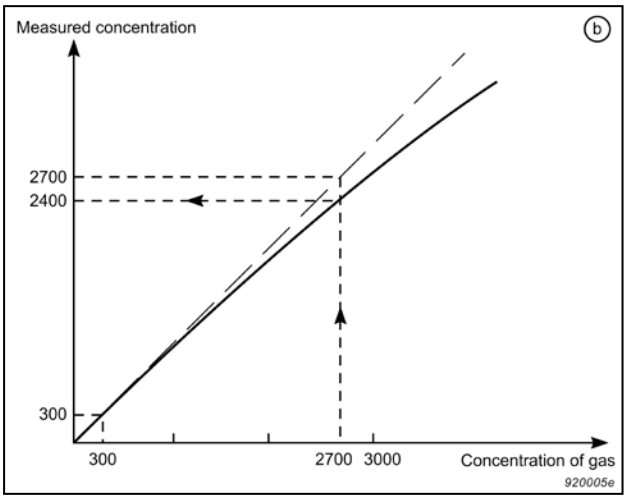


Fig.14.20b Graph showing a non- linear measurement curve



The question about whether to perform a single- or a two-point span calibration is difficult to answer, as it is dependent on how linear the relationship is between a gas's concentration and the signal it produces in the cell (see Fig.14.19, Fig.14.20a and Fig.14.20b). However, we can give you some guidelines on whether you have to perform a single- or a two-point span-calibration.

- Single-point calibration should be used when you wish to measure in the linear range. We define the linear range as the dynamic concentration range in which you can measure with an error of 5% of the real concentration (this is illustrated in Fig.14.20b). For the most common gases, the linear range is from its detection limit and up to 10 000 times its detection limit.

- Two-point calibration is recommended to be used when you wish to measure in the non-linear range and when you wish to measure over a dynamic range of 100 000.

Gas Concentrations – Single-point Calibration

If a single-point span-calibration is performed then the span gas should have a concentration which is at least 100 times its detection limit and preferable not more than the highest concentration you expect to measure.

For certain gases it can be inexpedient to use a concentration of at least 100 times its detection limit, e.g. if you wish to measure a poisonous gas with a high detection limit, it would be natural to use a lower concentration. However, this means that the noise and vibration will have a larger influence on the calibration. This must, therefore, be taken into account when considering using a lower concentration.

Gas Concentrations – Two-point Calibration

During a two-point span calibration, the total signal in the cell (V_{low}) is measured first with a low concentration (C_{low}) of span gas, and then the total signal in the cell (V_{high}) is measured with a high concentration (C_{high}) of span gas. This enables the Monitor to compensate for any un-linearity in the relationship between the signal measured in the cell and the concentration of the gas in the cell (this is illustrated, for a gas A1, in Fig.14.20a).

Here are some guidelines about the concentration of gas you should use during a two-point span calibration:

- The **Low Concentration** should be 10 to 30% of the highest concentration you expect to measure.

If the desired measurement range is mainly within the linear range then the low concentration should be between 1000 and 10 000 times the detection limit.
If the desired measurement range is mainly above the linear range then the low concentration should be more than 10 000 times the detection limit.

- The **High Concentration** should be 75% to 100% of the highest concentration you expect to measure, but no higher than this.

Simple Test to Determine the Linearity

Let us assume that you wish to measure a gas over a dynamic range from 100 ppm and 3000 ppm of a gas that has a detection limit of 0.3 ppm.

In this case, the range in which you want to measure is from 333 times to 10 000 times the detection limit. With our general guidelines, you're not able to decide whether you have to perform a single- or two-point calibration. Therefore, we advise you to perform the following test:

1. Perform a single-point calibration with a low concentration of the gas. Use 10% of the highest expected concentration level. In this case, use 300 ppm (1000 times the detection limit).

2. Perform a measurement with a high concentration of the gas. Use, for example, 90% of the highest expected concentration level. In this case, use 2700 ppm.

If the measured gas concentration differs by more than 5% from the real concentration, then a two-point calibration with 2 gas concentrations is recommended.

In the example in Fig.14.20b, we have measured 2400 ppm with 2700 ppm gas. This gives an error of 11% and an even greater error at the highest concentration level.

14.11.1 Setting-up a Span Calibration – 7304 PC Use

If the span gas used during a span calibration task absorbs any of the light from the other installed optical filters, then it is advisable to perform a **cross-interference calibration**. This means that during span calibration the signal in the cell is not only measured with the water-vapour filter and the filter being span calibrated, but is also measured with all the other installed optical filters. Note that cross-interference calibration cannot be performed alone, it has to be performed together with span calibration.

The general equipment necessary to perform a calibration task is described in section 14.4. Follow the procedure from step 1 to step 3 inclusive and then follow the instructions in section 14.5.1 up to step 7.

Calibration index card

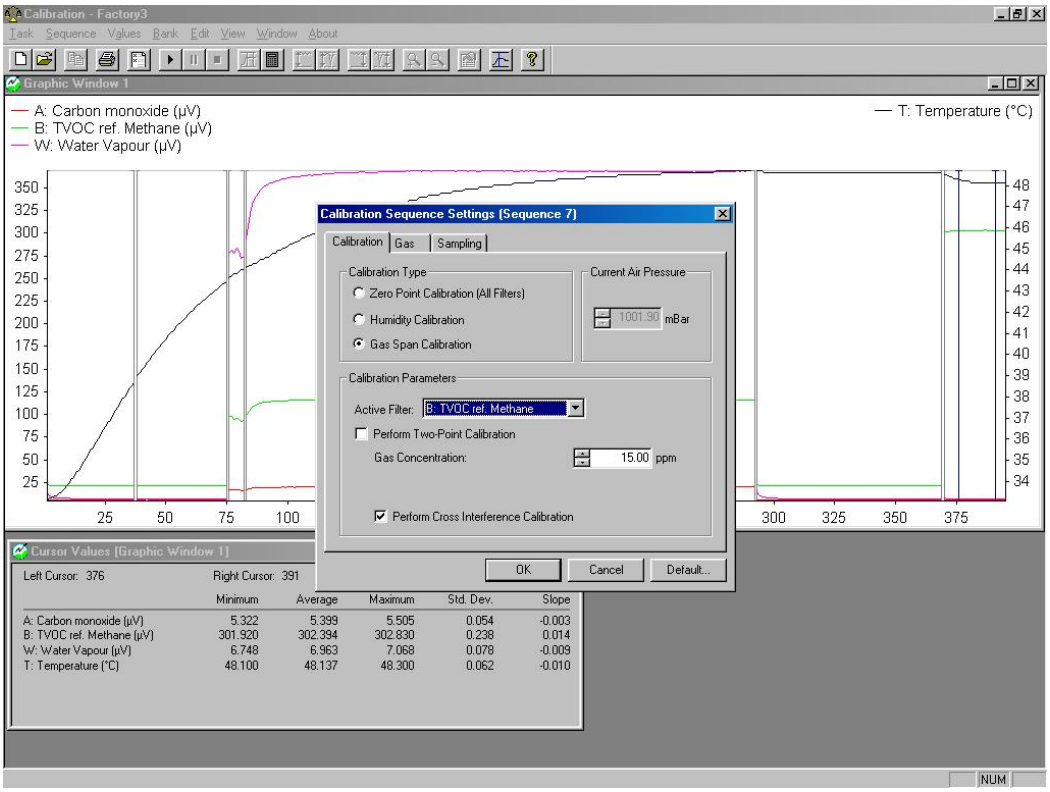
1. Click in the Gas Span Calibration radio-button. The Calibration Parameters group is displayed as shown, see Fig.14.21.

2. Select the filter position you want to calibrate.
   If you are recalibrating the monitor, using the same filter positions and filter banks, then the gas name displayed here is likely to be correct. If not go to step 10.
   If you are calibrating for a new gas, or an existing gas in a new filter bank, then the gas name and molecular weight need to be typed in. This is done via the “Gas” index card. Go to step 10.

3. If you require a Single-point calibration, go to step 4.
   If you require a Two-point calibration, go to step 5.

4. Ensure that the Perform Two-point Calibration check box is empty.

Fig.14.21 Span Calibration dialogue


Calibration - Factory3
Task Sequence Values Bank Edit View Window About
Graphic Window 1
A: Carbon monoxide (µV)
B: TVOC ref. Methane (µV)
W: Water Vapour (µV)
T: Temperature (°C)
Calibration Sequence Settings (Sequence 7)
Calibration Gas Sampling
Calibration Type
Zero Point Calibration (All Filters)
Humidity Calibration
Gas Span Calibration
Current Air Pressure
1001.90 mBar
Calibration Parameters
Active Filter: B: TVOC ref. Methane
Perform Two-Point Calibration
Gas Concentration: 15.00 ppm
Perform Cross Interference Calibration
OK
Cancel
Default...
Cursor Values [Graphic Window 1]
Left Cursor: 376
Right Cursor: 391
Minimum Average Maximum Std. Dev. Slope
A: Carbon monoxide (µV) 5.322 5.399 5.505 0.054 -0.003
B: TVOC ref. Methane (µV) 301.920 302.394 302.830 0.238 0.014
W: Water Vapour (µV) 6.748 6.963 7.068 0.078 -0.009
T: Temperature (°C) 48.100 48.137 48.300 0.062 -0.010
NUM

a. Type in the concentration of the calibration gas to be measured.

b. If a cross-interference calibration is necessary, tick the check box.

If you have not already set the S.I.T. values, click on the “Gas” index card and go to step 13. If you have set all the parameters on the “Gas” index card, return to the basic set-up instructions section 14.5.1 and continue from step 11.

5. Click in the Perform Two-point Calibration check box.

6. Click on either the High Gas Conc. or Low Gas Conc. radio-button.

7. Type in the correct gas concentration.

8. If you require a cross-interference calibration, click in this check box when the High Gas Conc. radio-button is selected.

9. Repeat steps 6. to 8. selecting the other gas concentration.

If you have not already set the S.I.T. values, click on the “Gas” index card and go to step 13. If you have set all the parameters on the “Gas” index card, return to the basic set-up instructions section 14.5.1 and continue from step 11.

Gas index card

10. Click on the “Gas” index card.

11. If you want to recalibrate using gas names already stored in the monitor’s filter banks, click in the *Gas Name* fields and select the desired gas names. Repeat this for all the loaded filter positions.
If you want to calibrate with a new gas, select the correct filter, pull down the *Gas Name* field to show all the filter banks. Click in the desired filter bank position and type in the gas name. Type in the correct molecular weight in the field next to the gas name.

12. Repeat step 11 until you have the correct gas names and molecular weights displayed for all the filters.

13. Click in the *Sample Integration Time* field and select the correct time.

Note: if you select Advanced, then you need to define the S.I.T. for the individual filter positions, including the water filter. These values should be the same as those used when monitoring.

If you are still setting up the calibration, click on the “Calibration” index card and go to step 3.

If you have already completed the “Calibration” index card, return to the basic set-up instructions, section 14.5.1 and continue from step 11.

Note: you need to span calibrate each filter individually. Therefore, these instructions need to be repeated to collect raw measurement data for each gas you want to span calibrate.

14.11.2 Setting-up a Span Calibration – Stand-alone Use

Fig.14.22 Schematic diagram showing how to set-up a span calibration task (follow the arrows)

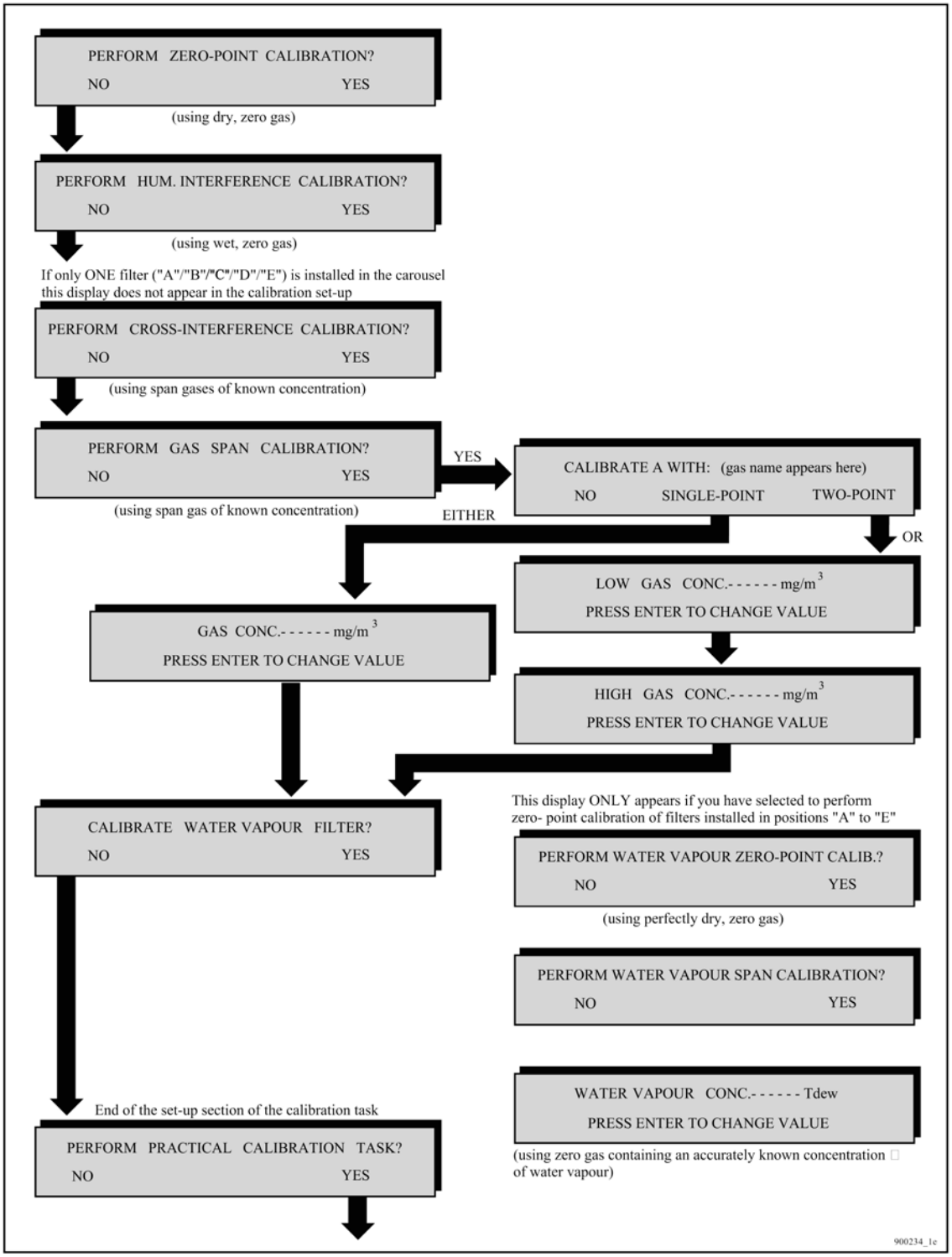
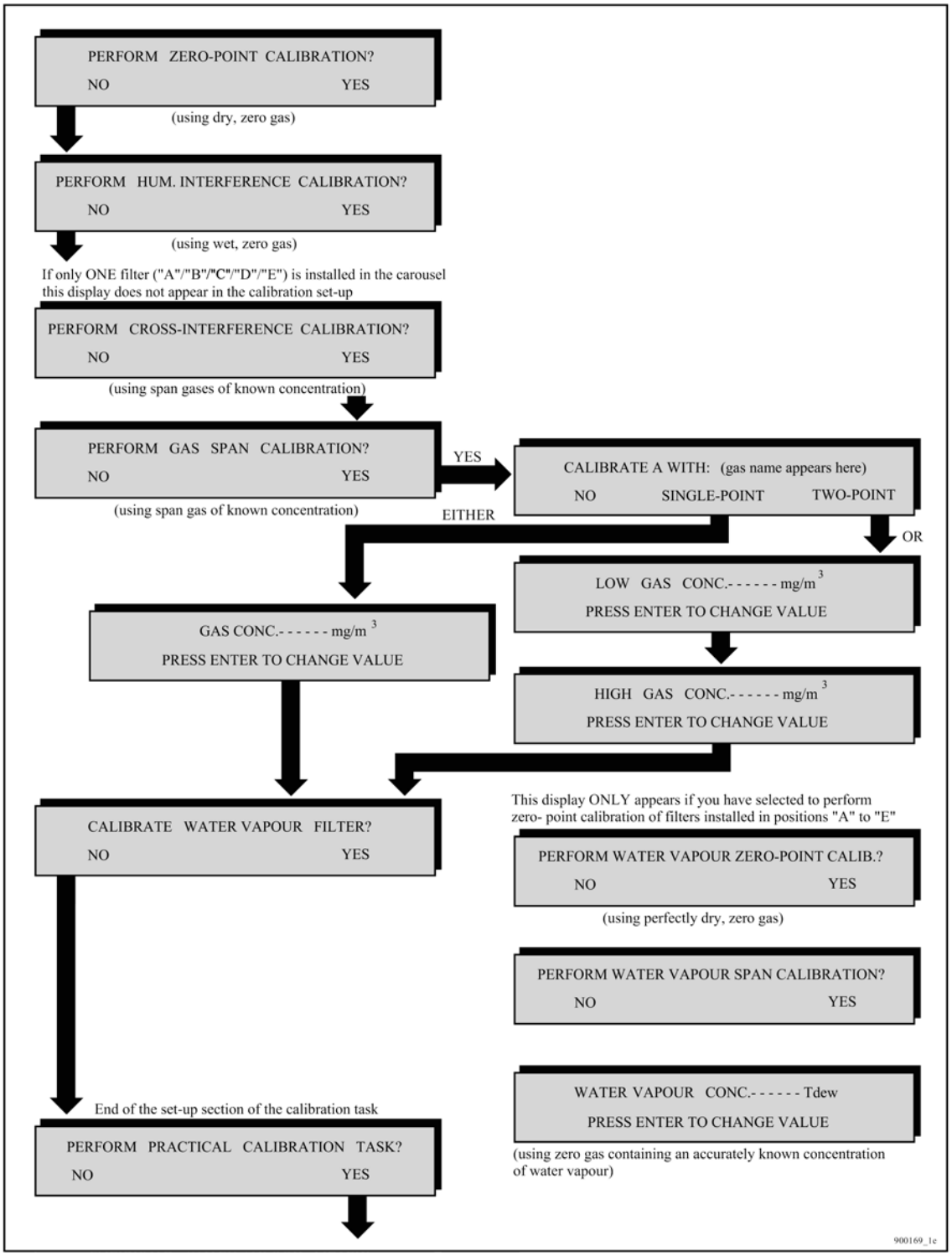

PERFORM ZERO-POINT CALIBRATION?
NO YES
(using dry, zero gas)
PERFORM HUM. INTERFERENCE CALIBRATION?
NO YES
(using wet, zero gas)
If only ONE filter ("A"/"B"/"C"/"D"/"E") is installed in the carousel this display does not appear in the calibration set-up
PERFORM CROSS-INTERFERENCE CALIBRATION?
NO YES
(using span gases of known concentration)
PERFORM GAS SPAN CALIBRATION?
NO YES
(using span gas of known concentration)
YES
CALIBRATE A WITH: (gas name appears here)
NO SINGLE-POINT TWO-POINT
EITHER
OR
GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
LOW GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
HIGH GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
CALIBRATE WATER VAPOUR FILTER?
NO YES
This display ONLY appears if you have selected to perform zero- point calibration of filters installed in positions "A" to "E"
PERFORM WATER VAPOUR ZERO-POINT CALIB.?
NO YES
(using perfectly dry, zero gas)
PERFORM WATER VAPOUR SPAN CALIBRATION?
NO YES
WATER VAPOUR CONC.- - - - - - Tdew
PRESS ENTER TO CHANGE VALUE
(using zero gas containing an accurately known concentration of water vapour)
End of the set-up section of the calibration task
PERFORM PRACTICAL CALIBRATION TASK?
NO YES
900234_1e

Fig.14.23 Schematic diagram showing how to set-up a combined cross-interference and span calibration task (follow the arrows)


PERFORM ZERO-POINT CALIBRATION?
NO YES
(using dry, zero gas)
PERFORM HUM. INTERFERENCE CALIBRATION?
NO YES
(using wet, zero gas)
If only ONE filter ("A"/"B"/"C"/"D"/"E") is installed in the carousel this display does not appear in the calibration set-up
PERFORM CROSS-INTERFERENCE CALIBRATION?
NO YES
(using span gases of known concentration)
PERFORM GAS SPAN CALIBRATION?
NO YES
YES
CALIBRATE A WITH: (gas name appears here)
NO SINGLE-POINT TWO-POINT
(using span gas of known concentration)
EITHER
OR
LOW GAS CONC.- - - - - - mg/m 3
PRESS ENTER TO CHANGE VALUE
GAS CONC.- - - - - - mg/m 3
PRESS ENTER TO CHANGE VALUE
HIGH GAS CONC.- - - - - - mg/m 3
PRESS ENTER TO CHANGE VALUE
CALIBRATE WATER VAPOUR FILTER?
NO YES
This display ONLY appears if you have selected to perform zero- point calibration of filters installed in positions "A" to "E"
PERFORM WATER VAPOUR ZERO-POINT CALIB.?
NO YES
(using perfectly dry, zero gas)
PERFORM WATER VAPOUR SPAN CALIBRATION?
NO YES
WATER VAPOUR CONC.- - - - - Tdew
PRESS ENTER TO CHANGE VALUE
(using zero gas containing an accurately known concentration of water vapour)
End of the set-up section of the calibration task
PERFORM PRACTICAL CALIBRATION TASK?
NO YES
900169_1e

If the span gas used during a span calibration task absorbs any of the light from the other installed optical filters, then it is advisable to select to perform a **cross-interference calibration**. This means that during span calibration the signal in the cell is not only

measured with the water-vapour filter and the filter being span calibrated, but is also measured with all the other installed optical filters. Note that cross-interference calibration cannot be performed alone, it has to be performed together with span calibration.

1. For each filter being span calibrated, enter the No. of the filter bank where you wish the Monitor to store the **conversion factors** which will be calculated during the span calibration task.

2. Press **MEASURE** **S3** **S3** **S1** then the following text will be displayed:

PERFORM ZERO-POINT CALIBRATION?
NO **YES**

3.
   a. If you only wish to span calibrate filters, follow the set-up of a span calibration task by following the black arrows in the schematic diagram shown in Fig.14.22.

   b. If you wish to perform cross-interference calibration as well as span calibration, follow the set-up of the combined calibration task by following the black arrows in the schematic diagram shown in Fig.14.23.

The following text will appear on the display:

CONNECT (the name of the gas appears here) **XXXXXXmg/m^3** **AND PRESS ENTER WHEN READY**

Note: if the gas concentration on the "Analysis Certificate" is given in ppm then the following formula can be used to convert from parts per million units (ppm) to mg/m^3:

For a gas at 20°C and at 1 atmosphere pressure:

$$\text{Concentration (in mg/m}^3\text{)} = \left(\frac{\text{Concentration (in ppm) x Molecular Weight (in g)}}{24{,}04} \right)$$

14.11.3 Performing a Span Calibration – Stand-alone Use

The general equipment necessary to perform a calibration task is described in section 14.4. Follow the procedure from step 1 to step 3 inclusive and then continue as follows:

1.

a. Connect the free-end of the Teflon tubing mentioned in step 3 to the pressure valve on a cylinder of calibration gas.

b. Press ↵.

c. Gently open the pressure-valve on the gas cylinder and regulate the flow of gas so that when the Monitor's pump is running there is a positive flow of gas out of the flow meter. This will ensure that the calibration gas is not diluted by atmospheric air.

The following text appears on the screen:

RESULTS NOT YET AVAILABLE
PLEASE WAIT

Once the first measurement result is available the screen text illustrated above is replaced by a screen displaying the measurement results – for example the following:

W: μ: 5.34 μV σ: 212 nV 3 40.4 °C
PRESS ENTER WHEN RESULTS ARE STABLE

As soon as measurement results are available, they not only appear on the display (see Fig.14.17) but are automatically printed out on the printer, if the Monitor has been set up to print a data log, see section 12.5. Remember to turn off the data log when the calibration is complete.
Each time a sample of gas is drawn into the analysis cell the signal is measured using both optical filter "A" and the water-vapour filter ("W") but, due to lack of space on the **display**, the Monitor only displays the signal measured using the water-vapour filter. The data-log print-out, however, shows the signal measured using both the water-vapour filter and filter "A". If **cross-compensation calibration** was also selected in the calibration set-up, then the signal is measured in the cell using all the installed filters.
A maximum of 6 measurements are stored in the Monitor during any calibration. The number (n) indicates how many measurements are stored. When 7 measurements have been performed the number (n) will show the number 6 because the very first measurement is overwritten by the 7th measurement so that only 6 measurements are still stored. When 8 measurements have been completed the number (n) will also show 6 because the results of the first and second measurements have been overwritten by the 7th and 8th measurement results …and so on.

2. Let the Monitor continue measuring the span gas A until the temperature is stable. Look at the print-put of the average and standard deviation measurements for (1) the water-vapour and (2) the filter “A”. When these values have stabilised for both filters, span calibration measurements do not need to continue.

3. Press ↵.
   This causes the following text to appear on the screen:

A : μ : 123.8 μV σ : 617 nV 6 40.4 °C
PRESS ENTER WHEN RESULTS ARE STABLE

   These results have been shown on the data-log print-out. If they have stabilised continue to the next Step.

4. Press ↵.

The text **CALCULATING CALIBRATION FACTORS – PLEASE WAIT** appears on the screen.

The Monitor only uses the last six measurement results when calculating any calibration factor. The **conversion factor** (in mg/m3 per volt), which is calculated during a **span calibration**, is the factor which allows the Monitor to relate the signal produced by the gas to the concentration of gas in the cell. The **cross-interference factors**, which are calculated during **cross-compensation calibration** are those factors which allow the Monitor to compensate for any interference gas A has on the other installed optical filters.
If any calibration data is doubtful or unacceptable an error message (marked by an asterisk) will appear on the screen after the calibration factors have been calculated. Whenever an asterisk is shown on the screen further information about the condition of the Monitor can be obtained by pressing the **INFO** button.

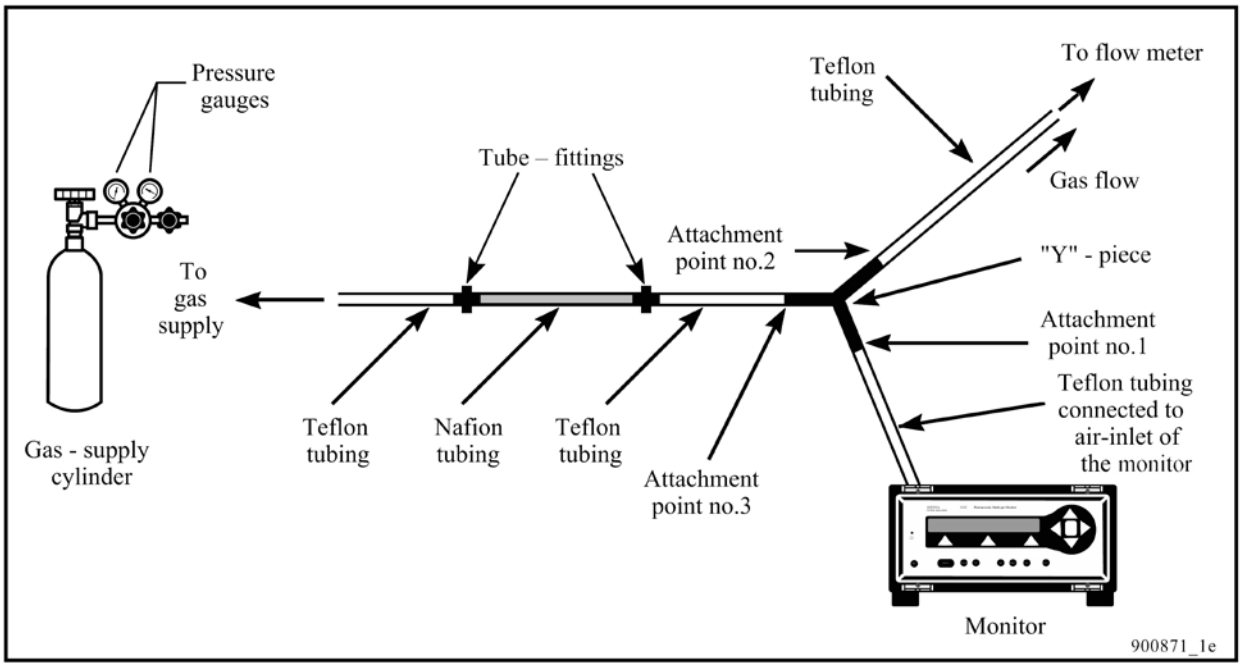
Chapter 16 lists all the error messages connected with doubtful calibration results and gives an explanation of their significance so that the user can ascertain what action to take if such messages are displayed after calibration.

14.11.4 Use of Nafion Tubing during Span Calibration of UA0983, UA0984 and UA0985.

A Nafion tubing (an optional accessory) is required during the span calibration of UA0983 e.g carbon dioxide (CO_2),UA0984 e.g. carbon monoxide (CO) and UA0985 e.g. dinitrogen oxide (N_2O). The Teflon tubing connected to attachment point no. 3 of the “Y”-piece should

be cut in half and a tubing should be connected between the two cut-ends of the teflon tubing using the tube fittings supplied for the purpose (Fig.14.24).

Fig.14.24 Diagram showing how to use Nafion tubing when span calibrating with one of the following optical filters: UA0983, UA0984 or UA0985



14.12 Calibration of the Water-vapour Filter – Stand-alone Use

The water-vapour filter has two different functions. Its most important function is to enable any measured signal to be compensated for water-vapour interference. Its other function is to measure the absolute concentration of water-vapour in air samples. If you only wish to use the water-vapour filter to compensate for water-vapour interference, then it only has to be **zero-point calibrated**. If you wish to use it to measure the absolute concentration of water vapour in air samples then it has to **be zero-point calibrated** and **span calibrated**.

It is **vitally** important to accurately zero-point calibrate the water-vapour filter as this influences the Monitor's ability to compensate for interference from water vapour. This demands that the zero-gas you use during the zero-point calibration of the filter must be perfectly dry.

14.12.1 Setting-up a Zero-point Calibration of the Water-vapour Filter

If you wish to zero-point calibrate the water-vapour filter you **must** zero-point calibrate all the other installed optical filters. The **concentration offset factors** calculated during zero-point calibration of the filter "A" to "E" will be stored in the filter banks, (those **active** during calibration). Check, therefore, that you make the relevant filter banks active for these filters before calibrating them. This is discussed in more detail in section 14.3.3.

The procedure for setting-up a zero-point calibration of the water-vapour filter is as follows:

1. Press **Measure** **S3** **S3** **S1** then the following text will be displayed:

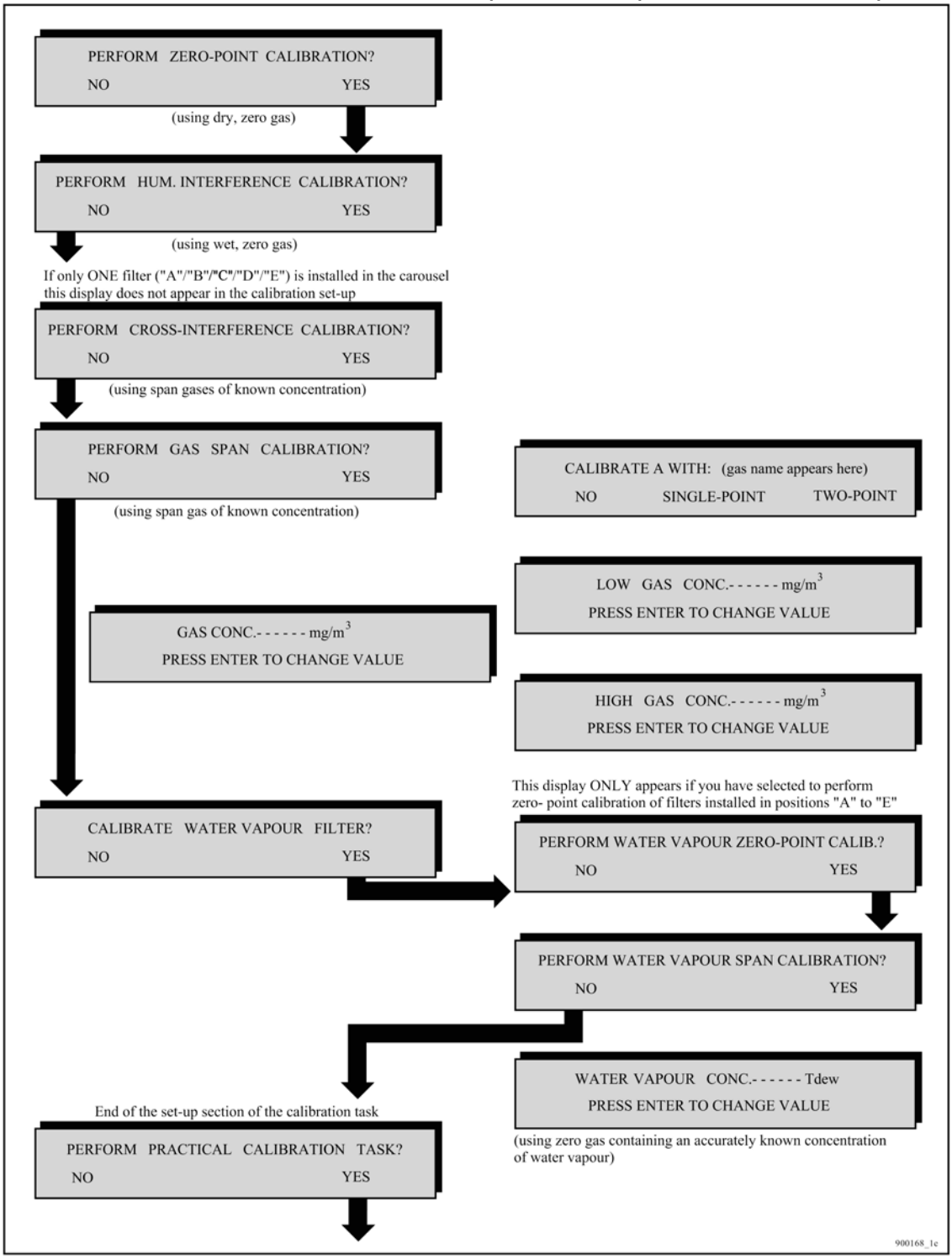
PERFORM ZERO-POINT CALIBRATION ?
NO YES

2. Follow the set-up of a zero-point calibration of the water-vapour filter by following the black arrows in the schematic diagram shown in Fig.14.25.

The following text will appear:

ZERO-POINT CALIB. CONNECT CLEAN, WET AIR AND PRESS ENTER WHEN READY

Fig.14.25 Schematic diagram showing how to set-up a zero-point calibration task for the water-vapour filter (follow the arrows)


PERFORM ZERO-POINT CALIBRATION?
NO YES
(using dry, zero gas)
PERFORM HUM. INTERFERENCE CALIBRATION?
NO YES
(using wet, zero gas)
If only ONE filter ("A"/"B"/"C"/"D"/"E") is installed in the carousel this display does not appear in the calibration set-up
PERFORM CROSS-INTERFERENCE CALIBRATION?
NO YES
(using span gases of known concentration)
PERFORM GAS SPAN CALIBRATION?
NO YES
(using span gas of known concentration)
CALIBRATE A WITH: (gas name appears here)
NO SINGLE-POINT TWO-POINT
LOW GAS CONC.- - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
GAS CONC.- - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
HIGH GAS CONC.- - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
This display ONLY appears if you have selected to perform zero- point calibration of filters installed in positions "A" to "E"
CALIBRATE WATER VAPOUR FILTER?
NO YES
PERFORM WATER VAPOUR ZERO-POINT CALIB.?
NO YES
PERFORM WATER VAPOUR SPAN CALIBRATION?
NO YES
WATER VAPOUR CONC.- - - - - Tdew
PRESS ENTER TO CHANGE VALUE
(using zero gas containing an accurately known concentration of water vapour)
End of the set-up section of the calibration task
PERFORM PRACTICAL CALIBRATION TASK?
NO YES
900168_1e

14.12.2 Performing a Zero-point Calibration of the Water-vapour Filter

As explained in the previous section, a zero-point calibration of the water-vapour filter has to be done together with the zero-point calibration of the other installed optical filters. The latter task has been fully described in section 14.7. It is worth-while to emphasise again that it is **vitally important** to use perfectly dry zero-gas (that is, zero-gas which contains 0% water-vapour) during this calibration.

Note that during the zero-point calibration of filters “A” to “E” (task 1, shown below), and during the combined zero-point calibration of filters “A” to “E” **and** the water-vapour filter (task 2, shown below), a zero-gas supply is attached to the air-inlet of the Monitor. The Monitor measures the signal in the cell using the water-vapour filter and all the other installed optical filters. Signals measured with filters “A” to “E” enable the **concentration offset factors** for filters “A” to “E” to be stored in the filter banks which are **active** during calibration. However, the signal measured with the water-vapour filter is used differently:

In Task 1:
The signal measured with the water-vapour filter is used to compensate all measured signals for any interference caused by the presence of any residual water-vapour in the zero-gas supply.

In Task 2:
The signal measured with the water-vapour filter is used to update the **concentration offset factor** for the water-vapour filter. This means that the signals measured with filters “A” to “E” cannot be compensated for the presence of any water vapour present. This is why it is **vitally important** to use **perfectly dry** zero-gas during this task.

Please refer to section 14.7.3 for details about how to perform a zero-point calibration task.

14.12.3 Setting-up a Span Calibration of the Water-vapour Filter

Remember that span calibration of the water-vapour filter is only necessary if you wish to measure the absolute concentration of water vapour in air samples. If the water-vapour filter is not **span** calibrated you will not be able to measure the concentration of water vapour in gas samples during a monitoring task.

Before the water-vapour filter can be span calibrated, it has to be zero-point calibrated, that is, a **concentration offset factor** for the water-vapour filter must be stored in the Monitor's calibration data block.

During span calibration of the water-vapour filter it is necessary to attach a supply of zero-gas containing a known concentration of water vapour to the Monitor. As explained in the Humidity-interference Calibration (Section 14.9.2) it is important to use water-vapour whose concentration is below the saturated vapour pressure of water-vapour at the temperature of the room where calibration is to be performed, otherwise water-vapour will condense out in the analysis cell and damage it.

Before setting-up the span calibration of the water-vapour filter go into **Set-Up mode** and select "Tdew" as a humidity unit. Then when you have to enter the concentration of the water-vapour you will use during calibration. Always use water concentrations at least 2°C below the ambient room temperature. For example, if the ambient room temperature is 20°C then you can **ENTER WATER-VAPOUR CONC** as 18°Tdew.

The procedure for setting-up a span calibration of the water-vapour filter is as follows:

1. Press **Measure** **S3** **S3** **S1** then the following text will be displayed:

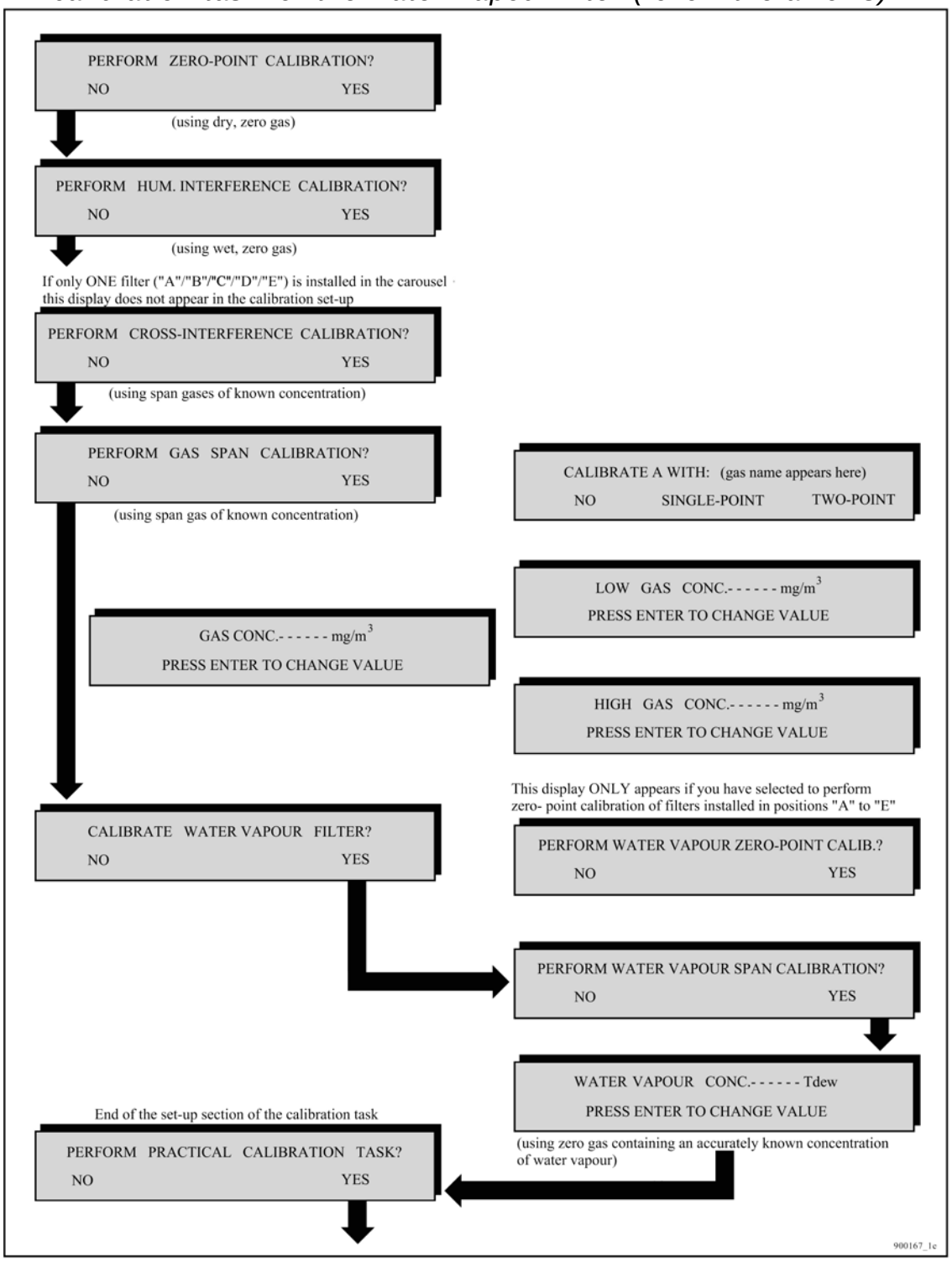
PERFORM ZERO-POINT CALIBRATION ?
NO YES

2. Follow the set-up of a span calibration of the water-vapour filter by following the black arrows in the schematic diagram shown in Fig.14.26.

The following text will appear:

CONNECT WATER-VAPOUR 18.0 Tdew
AND PRESS ENTER WHEN READY

Fig.14.26 Schematic diagram showing how to set-up a span calibration task for the water-vapour filter (follow the arrows)


PERFORM ZERO-POINT CALIBRATION?
NO YES
(using dry, zero gas)
PERFORM HUM. INTERFERENCE CALIBRATION?
NO YES
(using wet, zero gas)
If only ONE filter ("A"/"B"/"C"/"D"/"E") is installed in the carousel this display does not appear in the calibration set-up
PERFORM CROSS-INTERFERENCE CALIBRATION?
NO YES
(using span gases of known concentration)
PERFORM GAS SPAN CALIBRATION?
NO YES
(using span gas of known concentration)
CALIBRATE A WITH: (gas name appears here)
NO SINGLE-POINT TWO-POINT
LOW GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
HIGH GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
This display ONLY appears if you have selected to perform zero- point calibration of filters installed in positions "A" to "E"
CALIBRATE WATER VAPOUR FILTER?
NO YES
PERFORM WATER VAPOUR ZERO-POINT CALIB.?
NO YES
PERFORM WATER VAPOUR SPAN CALIBRATION?
NO YES
WATER VAPOUR CONC.- - - - - - Tdew
PRESS ENTER TO CHANGE VALUE
(using zero gas containing an accurately known concentration of water vapour)
End of the set-up section of the calibration task
PERFORM PRACTICAL CALIBRATION TASK?
NO YES
900167_1e

14.12.4 Performing a Span Calibration of the Water-vapour Filter

Section 14.4.1 describes a good method of producing water-vapour of known concentration. The directions for performing a span calibration of water-vapour filter are similar to those for performing a humidity-interference calibration of the other installed filters is as described in section 14.9.2. In both calibration tasks the signal in the cell is measured when a supply of zero gas containing a constant concentration of water vapour is attached to the Monitor. There are, however, two differences:

1. During a humidity-interference calibration the signal is measured using each of the installed filters (including the water-vapour filter), whereas during the span calibration of the water-vapour filter the signal is only measured with the water-vapour filter.

2. During a humidity-interference calibration, it is **not** necessary to know the concentration of water-vapour supplied to the cell as it is only necessary to measure the size of each signal (with filters "A" – "E") relative to the size of the signal measured with the water-vapour filter. However, during a span calibration of the water-vapour filter it **is** necessary to know the **exact** concentration of water-vapour supplied to the cell, because during this calibration the **conversion factor** is calculated. This factor relates the measured signal to the concentration of water-vapour in the cell.

Follow the procedure described in section 14.9.2.

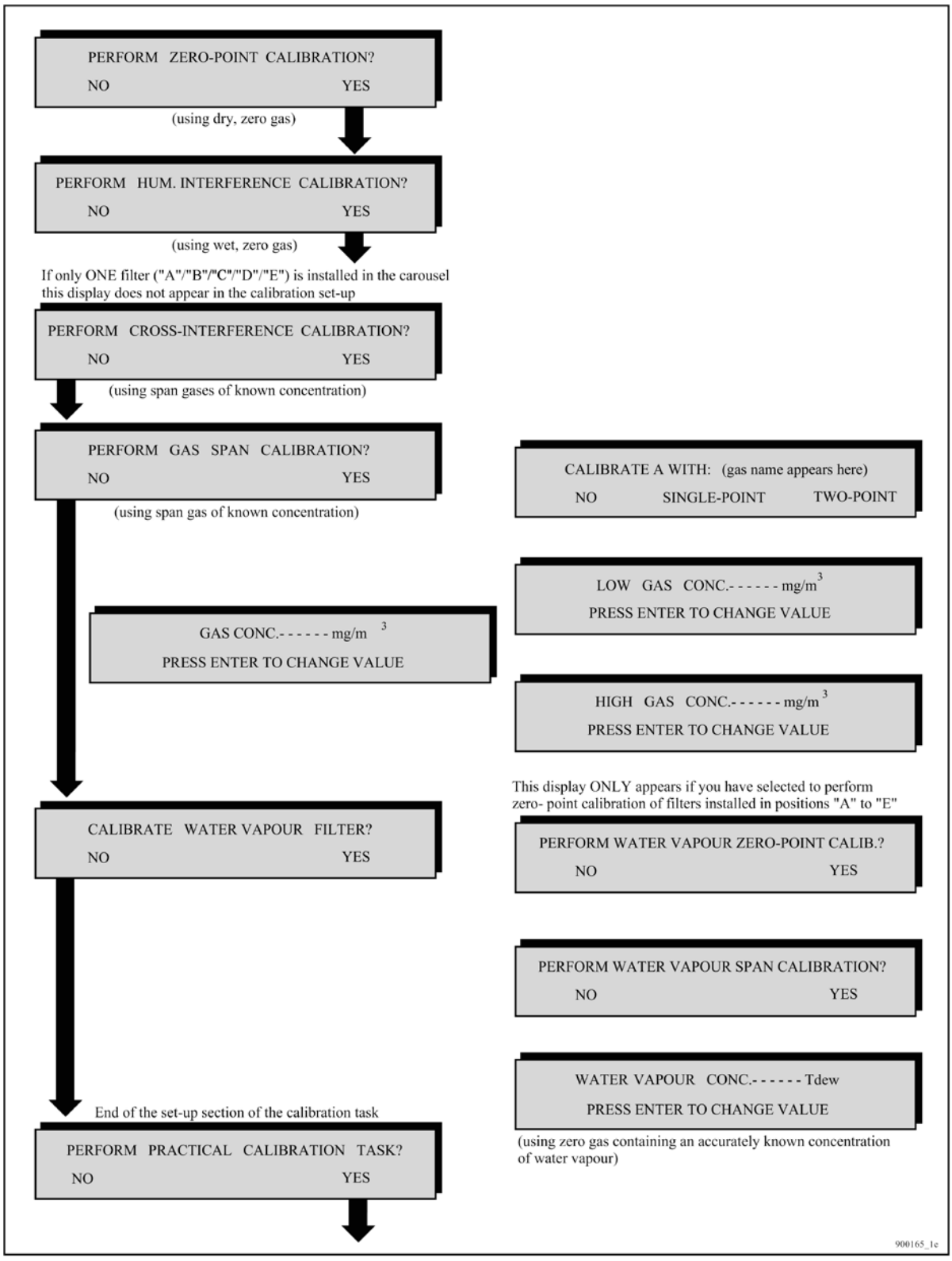
14.13 Setting-up a Combined Zero-point and Humidity-interference Calibration – Stand-alone Use

We have explained in previous sections of this chapter (section 14.7 and section 14.9.1) that a zero-point calibration can only be performed alone if a **humidity gain factor** is already stored in each of the filter banks which are **active** during the zero-point calibration task. Likewise, a humidity-interference calibration can only be performed alone if a **concentration offset factor** is already stored in each of the filter banks which is **active** during the humidity-interference calibration task.

If the necessary calibration factors are not stored in the Monitor's memory, a zero-point calibration task has to be performed together with a humidity-interference calibration task.

The procedure for setting-up a **combined** zero-point **and** humidity-interference calibration task is as follows:

Fig.14.27 Schematic diagram showing how to set-up a combined zero-point and humidity-interference calibration task (follow the arrows)


PERFORM ZERO-POINT CALIBRATION?
NO YES
(using dry, zero gas)
PERFORM HUM. INTERFERENCE CALIBRATION?
NO YES
(using wet, zero gas)
If only ONE filter ("A"/"B"/"C"/"D"/"E") is installed in the carousel this display does not appear in the calibration set-up
PERFORM CROSS-INTERFERENCE CALIBRATION?
NO YES
(using span gases of known concentration)
PERFORM GAS SPAN CALIBRATION?
NO YES
(using span gas of known concentration)
CALIBRATE A WITH: (gas name appears here)
NO SINGLE-POINT TWO-POINT
LOW GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
HIGH GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
This display ONLY appears if you have selected to perform zero- point calibration of filters installed in positions "A" to "E"
CALIBRATE WATER VAPOUR FILTER?
NO YES
PERFORM WATER VAPOUR ZERO-POINT CALIB.?
NO YES
PERFORM WATER VAPOUR SPAN CALIBRATION?
NO YES
WATER VAPOUR CONC.- - - - - - Tdew
PRESS ENTER TO CHANGE VALUE
(using zero gas containing an accurately known concentration of water vapour)
End of the set-up section of the calibration task
PERFORM PRACTICAL CALIBRATION TASK?
NO YES
900165_1e

1. Press **Measure** **S3** **S3** **S1** then the following text will be displayed:

PERFORM ZERO-POINT CALIBRATION ?
NO YES

2. Follow the set-up of a combined zero-point and humidity-interference calibration by following the black arrows in the schematic diagram shown in Fig.14.27.

The following text will appear:

ZERO-POINT CALIB. CONNECT CLEAN, DRY AIR AND PRESS ENTER WHEN READY

3. Refer to section 14.7.3 for the practical details of a zero-point calibration task.

When the zero-point calibration task is complete, the following text appears on the screen:

HUM. INTERFERENCE. CONNECT CLEAN, DRY AIR AND PRESS ENTER WHEN READY

4. Refer to Section 14.9.2 for the practical details of a humidity-interference calibration task.

14.14 Setting-up any Combined Calibration – Stand-alone Use

Although we have separated the various calibration tasks and described how to set them up and perform them alone, it is, of course possible to set-up any combination of calibration tasks, for example, that combining the zero-point and humidity-interference calibration tasks described in Section 14.13.

After setting-up any combined calibration task, the Monitor responds by telling you about which gas supply is required for each calibration task.

When the combined calibration task is complete, the text **CALCULATING. PLEASE WAIT** appears on the screen.

If any calibration data is uncertain or unacceptable an error message (marked by an asterisk) will appear on the screen after the calibration factors have been calculated. Whenever an asterisk is

shown on the screen further information about the condition of the Monitor can be obtained by pressing **INFO**.

Chapter 16 lists all the error messages connected with uncertain calibration results and gives an explanation of their significance so that the user can ascertain what action to take if such messages are displayed after calibration.

Chapter 15

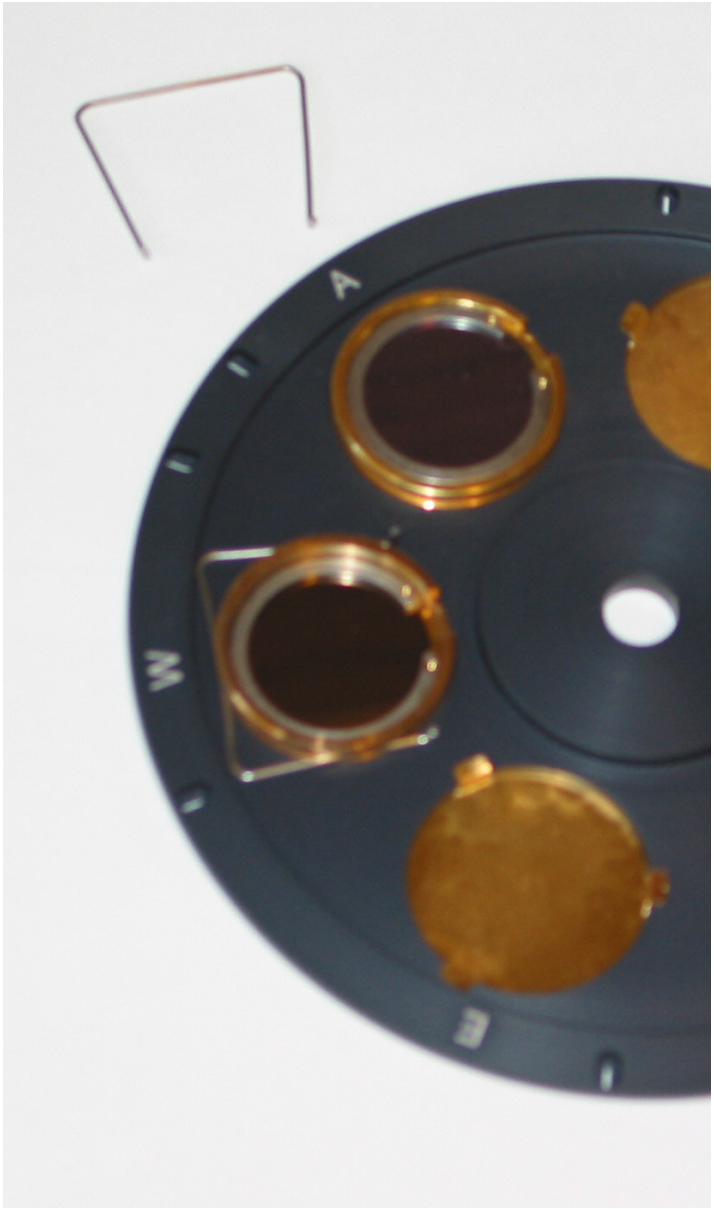
Installing the Optical Filters

October 2012

15.1 Introduction

Each of the optical filters available for use with the Monitor, have a “UA” number printed on them. The “UA” numbers run from UA 0968 – UA 0989 and UA 0936. The Monitor has a carousel wheel on which relevant optical filters are mounted. There are six mounting holes in the carousel. Each mounting hole is labelled with one of the following letters: “A”, “B”, “C”, “D”, “E” and “W” (see Fig.15.1). Before leaving the factory a special “water” filter is mounted in the position marked “W” and user-chosen optical filters are mounted in the other positions of the carousel. If less than 6 optical filters are installed in the carousel, blank plates are mounted in those positions of the carousel where no optical filter has been installed.

Fig.15.1 The filter carousel in the Monitor



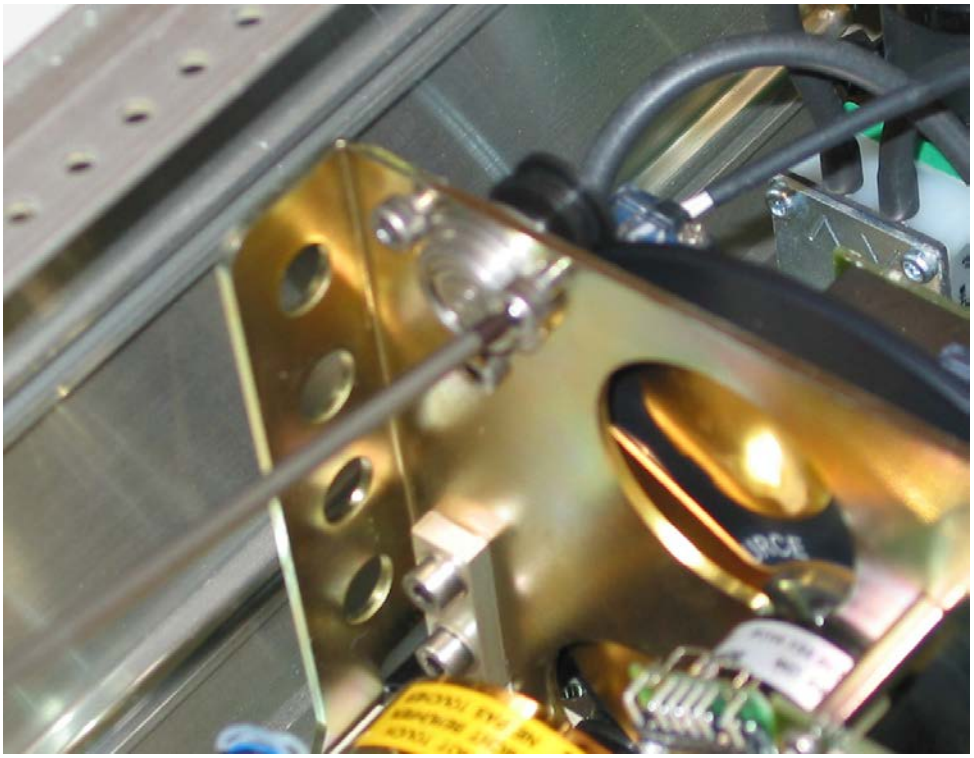
Blank plates may only be removed from the carousel if they are replaced by a chosen optical filter. Each blank plate is held in position on the wheel by three lugs (see Fig.15.1). The blank plate can be taken out of the mounting hole by bending the metal lugs towards the centre of the plate using your fingernail. The chosen optical filter is installed in the open mounting hole and “locked” into position on the carousel with a “locking” spring.

15.1.1 Installing an Optical Filter in the Monitor.

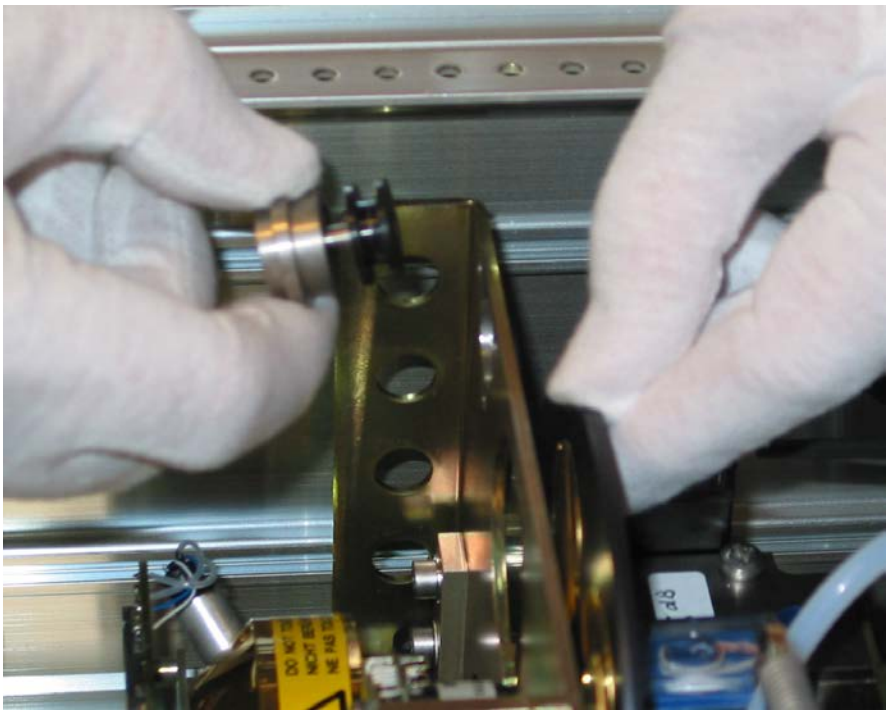
Important! Always use gloves when handling the optical filters.

1. Remove the top lid.
(See section 2.3.2).

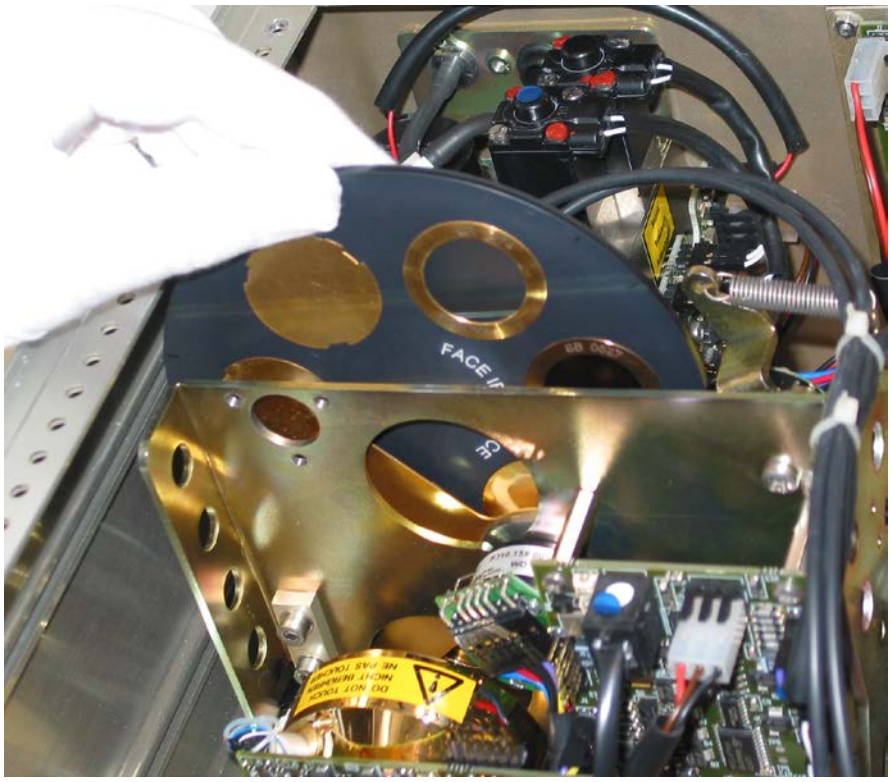
2. Remove the three screws, which holds the filter-wheel pulley:



3. Remove the pulley:

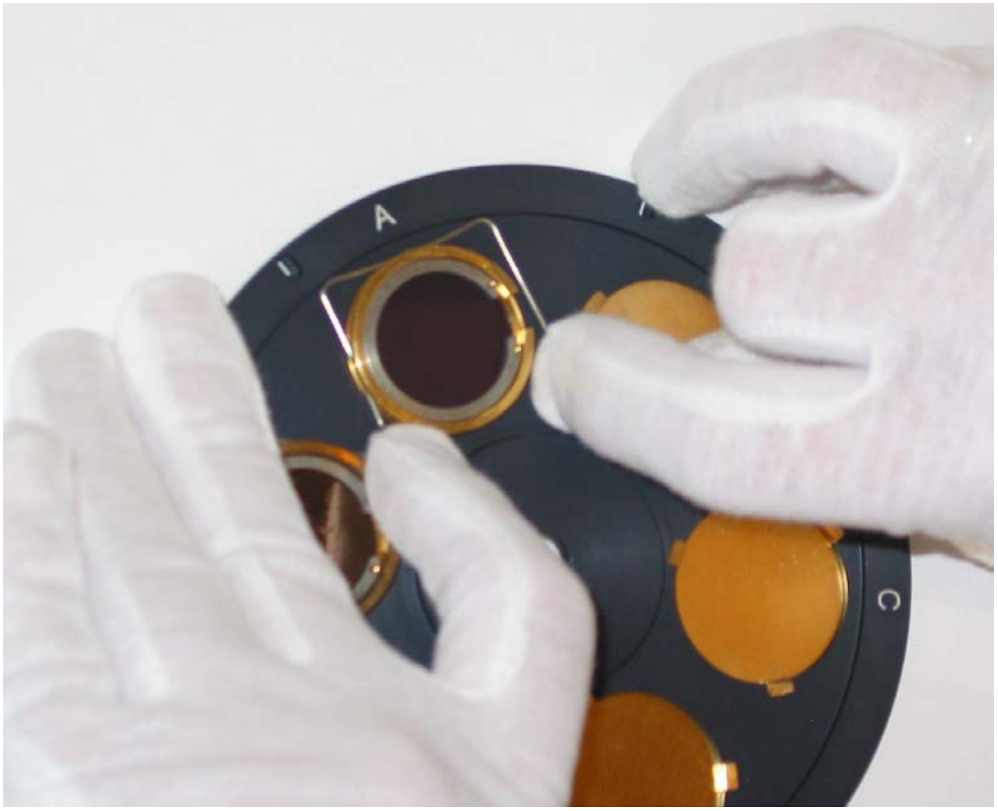


4. Take out the Filter Wheel:



5. Using clean gloves lift the chosen optical filter out of its box by holding its edge between the thumb and forefinger.

6. Insert the Optical Filters and fit the locking spring. Check that the locking spring is fitted correctly around the groove of the optical filter.



7. Reinsert the Filter Wheel with the mark “Face IR-Source” towards the IR-source.

8. Note the UA number of each optical filter and its position in the filter carousel (for example, UA 0983 in position “B”, UA 0988 in position “D” and so on).

9. Enter the correct UA number of the optical filter installed in each position (“A” to “E”) of the filter carousel – section 14.3.3 provides details. This is a **very important** step as it determines the set of Optical Filter Factors, which will be used during the calibration of each optical filter. If the UA number is not correctly entered then the filter cannot be calibrated to measure any gas accurately.

Chapter 16

Messages Related to Calibration

October 2012

All the possible error messages connected with calibration results are discussed in this chapter. Messages fall into three calibration categories: (1) successful; (2) uncertain and (3) invalid. An explanation is given of each message and its significance so that the user can ascertain what action to take if such messages are displayed after calibration.

16.1 "Successful" Calibration Messages

The messages listed below indicate (1) that the calibration task you have just performed has been successful, and (2) that the calibration factor calculated during the calibration task has been stored in the filter bank which was **selected / active** during the calibration task.

ZERO-POINT CALIBRATION SUCCESSFUL
HUM. INTERFERENCE CALIBRATION SUCCESSFUL
ZERO-POINT/HUM. INTERF. CALIB. SUCCESSFUL
GAS X* SINGLE-POINT CALIBRATION SUCCESSFUL
GAS X* TWO-POINT CALIBRATION SUCCESSFUL

Where Gas X is the gas used during the span calibration of the filter installed in position "X" of the filter carousel (Where: X = "A" to "E" or "W").

16.2 "Successful *" Calibration Messages

The messages listed below indicate (1) that the calibration task you have just performed is perhaps not as good as can be expected; (2) that the calibration factor which has just been calculated **has** been stored in the filter bank which was active during the calibration task; and (3) that you will have to judge the validity of the calibration. If you judge it to be invalid then the task will have to be repeated so that the calibration factor stored in the filter bank can be overwritten by a new and valid factor.

You can find out why there is uncertainty about the validity of the calibration factor by pressing **INFO**.

The messages displayed when **INFO** is used are discussed in section 16.4.

ZERO-POINT CALIBRATION SUCCESSFUL*
HUM. INTERFERENCE CALIBRATION SUCCESSFUL*
ZERO-POINT/HUM. INTERF. CALIB. SUCCESSFUL*
GAS X* SINGLE-POINT CALIB. SUCCESSFUL*
GAS X* TWO-POINT CALIBRATION SUCCESSFUL*

16.3 "Invalid" Calibration Messages

The messages listed below indicate: (1) that the calibration factor calculated during the calibration task you have just performed is not valid and therefore has not been stored in any filter bank; and (2) that the calibration task must therefore be repeated.

ZERO-POINT CALIBRATION INVALID*
HUM. INTERFERENCE CALIBRATION INVALID*
ZERO-POINT/HUM. INTERF. CALIB. INVALID*
GAS X* SINGLE-POINT CALIB. INVALID*
GAS X* TWO-POINT CALIBRATION INVALID*

16.4 Error Messages Displayed when the INFO button is used

All "successful*" or "invalid" calibration messages are marked with an asterisk (*) which tells you that more detailed information about the calibration can be obtained by pressing **INFO**. The messages displayed when **INFO** is pressed are listed and explained below.

16.4.1 "Invalid" Error Messages

MISSING MEASUREMENT DATA

This message indicates that the Monitor does not have the necessary data to calculate absolutely valid calibration factors. This situation could, for example, be caused by too much noise in the analysis chamber. The calibration task will have to be repeated.

WATER VAPOUR MEASUREMENT < OFFSET

This message is associated with either (1) a span calibration of the water-vapour filter, or (2) a humidity-interference calibration.

This message indicates that the signal measured with a particular filter, when water-vapour of known concentration is in the analysis cell, is less than the signal measured in the cell when zero-gas is in the cell. This could indicate either:

- That the gas used during the zero-point calibration of the filter was not dry;
  or
- That the water vapour used during either the span calibration of the water-vapour filter; or the humidity-interference calibration, was not wet enough.

WET MEAS. < DRY MEAS. FOR WATER FILTER and

HUMIDITY INTERFERENCE FACTOR < 0

Both these messages are associated with a combined zero-point and humidity-interference calibration task.

WET MEAS. < DRY MEAS. FOR WATER FILTER

HUMIDITY INTERFERENCE FACTOR < 0

During the zero-point calibration task the signal is measured when dry, zero gas is in the cell – this is a measure of the noise in the cell when a particular optical filter is used. This measurement allows the **concentration offset factor** for the particular filter to be calculated. During the humidity-interference calibration task the signal in the cell when a particular optical filter is used is measured when wet, zero gas is in the cell – this signal is compared with the signal measured with the water-vapour filter to give the **humidity gain factor**. The above message is given if the **humidity gain factor** is found to be less than zero. This could indicate that the zero-gas you used during the zero-point calibration was not dry, or alternatively that the concentration of water-vapour you used during the humidity-interference calibration was too low.

GAS X: CALIBRATION FACTOR LESS THAN 0

This message is associated with a single-point span calibration task.

The **gas conversion factor** calculated during the single-point span calibration task is found to be less than zero. This could indicate that the concentration of gas used during the calibration was too low.

GAS X: LOW MEAS. > HIGH MEAS.

GAS X: MEAS. INDICATES LINEAR COHERENCE

GAS X: MEAS. DOES NOT FIT NON-LINEAR CURVE

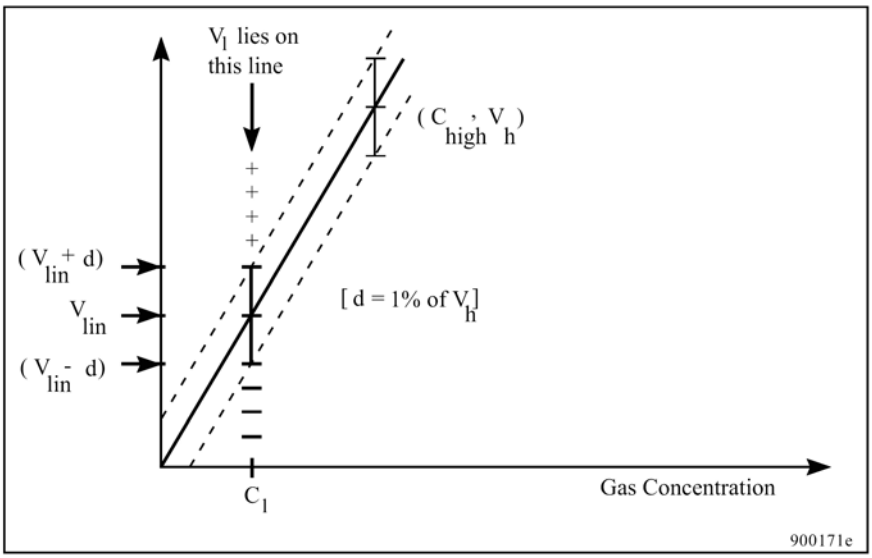
GAS X: CALIBRATION IMPOSSIBLE: MAX ITER.

All these messages are associated with a two-point span calibration task.

During a two-point span calibration the signal (V_{high}) is measured when the gas concentration C_{high} is in the cell, and the signal (V_{low}) is

measured when the gas concentration C_{low} is in the cell (see section 14.11).

Fig.16.1 Curve illustrating the two points measured during a two-point span calibration task



GAS X: LOW MEAS. > HIGH MEAS.

This message indicates that the signal measured in the cell when the gas concentration was low is found to be greater than the signal when the gas concentration was high.

The above message could indicate that the span gas concentrations were incorrectly “entered” when the task was set-up (that is, the “entered” low gas concentration was actually greater than the “entered” high gas concentration). Alternatively, it could indicate that the concentration of the gas supplied to the Monitor during the measurement of V_{low} was actually the high concentration (C_{high}) and vice versa.

The signals V_{high} and V_{low} have to be corrected for water-vapour interference and cell noise, that is:

$$V_{high} - V_{offset} - V_{H2O} = V_h;$$

and:

$$V_{low} - V_{offset} - V_{H2O} = V_l$$

These two points (V_h, C_h) and V_l, C_l) can then be plotted on a graph (see Fig.16.1).

When the two signals have been measured, the Monitor then finds the value δ = 1% of V_h and finds out the relationship between the measured values:

If there is a perfectly linear relationship between the points C_{low}, V_{low} and C_{high}, V_{high} then:

$$V_{lin} = (C_h / C_l) * V_l$$

GAS X: MEAS. INDICATES LINEAR COHERENCE

This message will be given in the status display if V_l lies between the values $V_{lin} - \delta$ and $V_{lin} + \delta$. This indicates that the two gas concentrations you have chosen lie in the linear region of the calibration curve. If the high concentration of gas you used (C_{high}) is equal to or greater than the highest concentration you expect to measure, then it is not necessary to use a two-point span calibration, a single-point span calibration using C_{high} as the concentration of span gas used will be sufficient to give you a good calibration result. However, if the high concentration of gas you used is less than the highest gas concentration you expect to measure, the two-point span calibration task should be repeated using a high concentration which is equal to or greater than the highest concentration you expect to measure. There will therefore be a better chance to find a point in the non-linear region of the span calibration curve so that any non-linearity can be plotted.

GAS X: MEAS. DOES NOT FIT NON-LINEAR CURVE

This message will be given in the status display if V_l is less than $V_{lin} - \delta$. This message indicates that a two-point span calibration cannot be performed.

If V_l is found to be greater than $V_{lin} + \delta$ then the Monitor will try to fit the two measured points onto a curve, whose shape has been pre-determined by *LumaSense*, by an iterative process. The iterative process involves scaling on the concentration and signal axes until the two points fit the curve within certain tolerances.

GAS X: CALIBRATION IMPOSSIBLE: MAX ITER.

If after 255 iterative processes, the two points cannot be fitted onto the curve within tolerance limits, this message is displayed.

This could indicate that the wrong concentration has been “entered” in the set-up of the span calibration task (which does not relate to the measured signal). Alternatively, it could indicate that there is a linear

relationship between the gas signal in the cell and the concentration of the gas (in which case only a single-point span calibration is required).

SPAN CALIBRATION IMPOSSIBLE

This message is associated with the span calibration of the water-vapour filter.

The above message indicates that the Monitor cannot calculate the **gas conversion factor**. This could indicate that the concentration of water-vapour used during the calibration was too low – this could either be due to an incorrectly “entered” water-vapour concentration in the set-up of the span calibration or that the concentration of water-vapour used was not the same as that which was “entered” in the set-up.

16.4.2 “Successful*” Error Messages

WATER VAP. MEAS. < OFFSET MEAS

This message is associated with one, or more, of the following calibration tasks: (1) the one- or two-point span calibration of an optical filter; (2) the cross-interference calibration of the installed optical filters ("A” to “E”); (3) the zero-point calibration of all the installed optical filters (“A” to “E”).

During all the above-listed calibration tasks, the signal in the cell is measured using the water-vapour filter: this enables the Monitor to compensate for any interference signal produced by the presence of any water-vapour in the span gas being used. If the signal in the cell using the water-vapour filter is found to be less than the **concentration offset factor** for the water-vapour filter, the above message is sent.

This could indicate that the zero gas you used, during the zero-point calibration of the water-vapour filter, was **not** perfectly dry.

SPAN MEASUREMENT TOO LOW

This message is associated with the span calibration of one (or more) of the filters.

The above message indicates that the signal measured in the cell during span calibration is less than 3µV and therefore cannot be used to obtain a good calibration. This means that the concentration of your span gas is too low.

SIGNIFICANT CHANGE IN CALIB. FACTORS

This message is associated with the span calibration of one (or more) of the filters.

The above message indicates that the **Conversion factor** calculated during span calibration of a particular filter deviates more than 15% from the **Conversion factor** calculated during the last span calibration of this filter. If you are absolutely sure that the previous span calibration of this filter was correctly performed then this message could indicate:

1. That you have “entered” the wrong concentration for the span-gas in the span calibration set-up.

2. That the concentration of your span gas is not correctly quoted on its “Analysis Certificate”.

3. That there is a leak in the tubing/fittings in your calibration equipment, which alters the concentration of the span gas reaching the cell.

NO CROSS INTERFERENCE FOUND

This message is associated with a combined cross-interference and span calibration task.

The above message indicates that the signal measured with a particular filter (for example “A”) when a certain gas (for example “B”) was in the cell is less than 1.5µV. This indicates that there is effectively no signal contribution from gas “B” when filter “A” is used, i.e. gas “B” does not interfere with measurements made with filter “A”. In this case the factor **“Gas B’s” Interference on Filter “A”** listed in the calibration data bank (see section 14.3.2) will be seen to be zero.

HIGH CONC. SPAN MEASUREMENT TOO LOW

This message is associated with a two-point span calibration task.

The above message indicates that the signal measured during span calibration, when the high concentration of span gas is in the cell, is less than 15µV. This means that the “high” concentration of span gas is too low.

LOW CONC. SPAN MEASUREMENT TOO LOW

This message is associated with a two-point span calibration task.

The above message indicates that the signal measured during span calibration, when the low concentration of span gas is in the cell, is less than 3µV. This means that the “low” concentration of span gas is too low.

Chapter 17

Warning and Error Messages

October 2012

When the Monitor is switched on, and while it is being operated, the Monitor regularly performs a series of self-tests, which check that the various mechanical, electrical and electronic components of the Monitor are functioning correctly. These self-tests are described in more detail in Chapter 5. You can select to disable the **regular self-tests** if desired (see section 5.4.3). If any component is found to be functioning outside of its specifications either a "Warning" or a "Operating-error" message will appear on the gas monitor's screen.

Please note: A "Warning" and/or "Operating-error" message will only be displayed **once**. If the fault is still found to be present during the next regular self-test the message will **not** be displayed again. Messages are only displayed when a fault is first detected. If the fault corrects itself and then is later found to be faulty the message will be displayed again. It is therefore important to note the message before pressing the **INFO** button, which will cause the error message to be removed from the display.

Although the message is removed from the screen, any gas measurements performed while the fault is still present will be marked with an asterisk (*). By pressing **INFO** when such a measurement is displayed, the **Common mark "O" and/or "W"**, and in some cases, the **Gas Mark "F"** and **Gas Mark "A"** will be shown on the display.

On the following pages, all possible "Warning" messages are listed; all possible "Operating-errors" messages are listed; and all possible "Interface-error" messages are listed. There is a description of each fault as well as the possible cause(s) of each fault. The user must evaluate the significance of each message. As long as the fault is detected, all measurements will be marked by an asterisk. Some "faults" are easily corrected.

Warning and Error Messages

The following table gives most of the error and warning messages contained in the test Hierarchy of the Monitor. There is a description of each fault as well as the possible cause of each fault. The user must evaluate the significance of each message.

Error / Warning Message	Description of Fault	Possible Cause
AIR FLOW TOO LOW	The air pressure difference created by the pump in the pneumatic (airway) system (tubes and/or analysis cell) is too low. This means that the tubing and/or analysis cell cannot be properly flushed out and the sample in the analysis cell is therefore not necessarily “new”	1. The length of the sampling tube attached to the Monitor’s inlet has been incorrectly entered. 2. Either the external or internal pneumatic system is not air-tight 3. The pump is defective
AIRWAY-SYSTEM BLOCKED	The air pressure difference created by the pump in the pneumatic (airway) system (tubes and/or analysis cell) is too high	1. The length of the sampling tube attached to the Monitor’s inlet has been incorrectly entered. Either the external or internal pneumatic system is not air-tight
ALARM LIMIT EXCEEDED	The Monitor has measured a concentration of gas greater than the alarm limit concentration entered	
NO INDEX MARK FROM FILTER CAROUSEL	The Monitor cannot determine the position of its filter carousel	1. The motor that drives the filter carousel is not working 2. The optical detector that checks the movement of the carousel is not working 3. The filter carousel has not been properly mounted

CLOCK SET TO DEFAULT ERROR DETECTED IN CLOCK SETTINGS	The Monitor's internal clock was found to be incorrectly set so these values have been set to their default values	A new battery has been installed
FACTORS SET TO DEFAULT ERROR DETECTED IN CALIBRATION FACTORS	An error has been found in the data stored in the Calibration Factor part of the Monitor's memory, so these factors have been set to their default values	1. A defective back-up battery 2. A defective Working Memory (RAM) or Source Memory (EEPROM) 3. A Software fault
MEMORY SET TO DEFAULT ERROR DETECTED IN BACKGROUND MEMORY	An error has been detected in the Monitor's Background Memory, so the Monitor automatically deletes all data stored in this Memory	1. A defective back-up battery 2. A defective Working memory (RAM) 3. A software fault
MEMORY SET TO DEFAULT ERROR DETECTED IN DISPLAY MEMORY	An error has been detected in the Monitor's Display Memory, so the Monitor automatically delete all data stored in this memory.	1. A defective back-up battery 2. A defective Working Memory (RAM) 3. A software fault
MEMORY SET TO DEFAULT ERROR DETECTED IN INTERNAL MEMORY	An error has been found in the data stored in the Monitor's internal memory. data stored in this memory cannot be read or altered by the user, so the Monitor automatically corrects any errors found in this memory	1. A defective back-up battery 2. A defective Working Memory (RAM) 3. A software fault.
MEMORY SET TO DEFAULT ERROR DETECTED IN SOURCE MEMORY	An error has been found in the data stored in the Monitor's source memory, so the Monitor automatically give stored parameters default values.	1. A defective back-up battery 2. A defective Source Memory (EEPROM) 3. A software fault
PARAMETERS SET TO DEFAULT ERROR DETECTED IN CONFIG:/FORMAT PARAMETER	An error has been found in the value parameters stored in the Configuration and/or Format branches of the Monitor's set-up tree, and therefore the Monitor has automatically given these parameters default values	1. A defective back-up battery. 2. A defective Working Memory (RAM) 3. A software fault.
PARAMETERS SET TO DEFAULT ERROR DETECTED IN THE TASK SET_UP PARAMETER	An error has been found in the value parameter stored in the Monitoring Task branch of the Monitor's set-up tree, and has automatically given these parameters default values.	1. A defective back-up battery 2. A defective Working Memory (RAM) 3. A software fault.

A/D INTERRUPT FAILED	A/D converter was not able to collect the necessary number of signal measurements to ensure an accurate concentration measurement.	The analogue card is defective.
AIR SHUNT BLOCKED. SAMPLE ABORTED	The pressure of air in the analysis cell is too high. The microphones risk being damaged by exposed to such pressure.	The air shunt valve is either defective or blocked.
CHOPPER FAILED	The chopper wheel is not running.	1. The chopper motor is not working 2. The optical sensor which checks the chopper´s movement is not working.
INTERNAL TEMPERATURE OUT OF RANGE	The temperature in the analysis cell is either too high or too low. As the Monitor is operating out-side its temperature specifications, accurate measurements cannot be guaranteed.	1. The ventilation fan is defective. 2. The ambient air temperature is either too high or too low. 3. The temperature sensor is defective.
IR-SOURCE TEMPERATURE OUT OF RANGE	The temperature of the infrared light source is either too high or too low. As the IR-source is oper-ating outside its temperature specifications accurate measurements cannot be guaranteed.	The infra-red light source is defective.
MICROPHONE TEST FAILED	The signal received from the microphone during the self-testing procedure is out of range.	1. The analogue card is defective 2. A microphone (s) is defective.
PUMP TEST FAILED	The pump cannot build up the necessary pressure during the self-testing procedure.	1. The pump is defective. 2. The internal pneumatic system is not airtight.
MODULE STATUS ERROR DETECTED	At least one of the modules is not functioning as expected.	1. Module hardware error. 2. Fault in communication cable 3. Wrong module version 4. Fault in the data configuration of the module

IEEE CONTROL TIMEOUT	The Monitor wishes to send data to a printer via IEEE interface, but the Monitor is not the system controller.	There are no other “controllers” on the IEEE bus, so the Monitor should be made the controller.
WARNING: X-ON/X-OFF HANDSHAKE CONFLICT	The Monitor receives the handshake signal from the RS232 CTS (clear to send) line, but it has not been set-up to use this CTS line	The Monitor and RS232 device (printer) do not agree about which handshake signal they should use. Perhaps the wrong interface cable has been used.
TIMEOUT. DEVICE NOT CONNECTED	Monitor wishes to send data (print , data-log or error-log) via the IEEE interface, but there is no response from the device with the address entered in the Monitor set-up	1 No device is connected to the Monitor 2 The device address has been entered incorrectly in the Monitor’s set-up.
WARNING : TIMEOUT. DEVICE NOT READY	Monitor wishes to send data (print, data-log or error-log) but after the start of data transmission , the device stops receiving data.	1. The device is “off-line“ (it can not receive data). 2. The device is not able to receive data fast enough. 3. The device is no longer connected to Monitor.

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